ELECTRICAL AND AIR EQUIPMENT SERVICE MANUAL

DIESEL-ELECTRIC LOCOMOTIVE

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

GENERAL ELECTRIC

6-68 (2500)

PRINTED IN U.S.A.

INTRODUCTION

This manual is intended for use by maintenance personnel. It will enable them to become acquainted with the locomotive in general and specifically with those details which relate to performing running maintenance. Running maintenance consists of such work as terminal servicing, minor repair and adjustments, interchanging small components, or any other work functions which will restore the locomotive to service within an eight-hour period.

The manual includes service information pertaining to major equipments and systems as applied to a production model locomotive. Therefore, instructions on specific customer modifications will not be included herein but will be part of the backshop manual, which includes all instructions dealing with heavy and running maintenance work.

Main subjects within this manual are arranged consecutively under separate section numbers. (Example: Section 4 Rotating Equipment.)

Illustrations which are identified by figure numbers within each section are keyed to the section by the section number and a figure number. (Example: Fig. 4-1.)

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LOCOMOTIVE DATA

MAJOR EQUIPMENT

Diesel Engine	7FDL16
Main Generator	GTA-9
Traction Motors	GE-752
Auxiliary Generator	GY-27
Exciter	GY-27
Air Compressor (Gardner-Denver)	WBO
Air Compressor (WABCO)	3CWDL
Fan Gear Unit	GA-57
Air Brake System	26L
Wheel Diameter (New)	40 inch
Permissible Variations in Size (40-Inch Diameter Wheel)	
Wheels on Same Axle	None
Wheels on a Locomotive Unit	25 Tapes

SYSTEM CAPACITIES

Fuel Oil (Large Tank)	4000 gal
Fuel Oil (Small Tank) (Optional)	1700 gal
Lubricating Oil	385 gal
Cooling Water	290 gal
Engine Governor	2 quarts
Fan Gear Unit	12 quarts
Compressor (Small Crankcase)	10 quarts
Compressor (Large Crankcase)	12 gal
Sand	48 cu ft

BRAKE SYSTEM ADJUSTMENTS

Brake Cylinder Piston Travel (Minimum) B-model	2 1/2 in.
Brake Cylinder Piston Travel (Minimum) C-model	3/4 in.
Brake Cylinder Piston Travel (Maximum) B-model	6 in.
Brake Cylinder Piston Travel (Maximum) C-model	3 1/2 in.

LOCOMOTIVE DATA

Compressor Governor Switch (Cut In)	130 psi
Compressor Governor Switch (Cut Out)	140 psi
Compressor Intercooler Safety Valve	60 psi
Main Reservoir Safety Valve	150 psi
Regulating Valve	Variable
Independent Brake Valve, Full Service, depends on railroad, cobra shoes, etc.	Variable
Control Air Reducing Valve	70 psi
Power Cutout Switch (PCS) (Open)	60 ± 2 psi
Power Cutout Switch (PCS) (Close)	45 ± 1 psi

OPERATING SETTINGS

Diesel Engine, Idle	400 ± 15 rpm
Diesel Engine, Full Speed	1025 ± 4 rpm
Overspeed Shutdown Trips	1130 ± 10 rpm
Diesel Engine Operating Temperature	155-170 F
Hot Engine Alarm (ETS) (Close)	208 ± 2 F
Hot Engine Alarm (ETS) (Open)	201 ± 2 F
Engine Lubricating Oil Header	
Pressure (Idle)	Approx 20 psi
Pressure (Full Throttle)	Approx 75 psi
Oil Pressure Shutdown (OPS)	
Engine at Idle (40 Second Delay)	7-10 psi
Engine Full Speed	45-50 psi
Low Water Shutdown	
Trip Pressure (Second Notch)	0-3 psi
Trip Pressure (Full Speed)	14-18 psi

ENGINE SYSTEM PRESSURE SETTINGS

Fuel Oil Pump Pressure, Relief Valve	75 psi
Fuel Header Pressure Regulating Valve	35 psi
Lubricating Oil Pump Pressure Relief Valve (Begins to Open)	135 psi

LOCOMOTIVE DATA

WEIGHTS (Approximate for Lifting Purposes Only)

Complete B-Locomotive (Fully Serviced)	270,000 lb
Complete C-Locomotive (Fully Serviced)	360,000 lb
One B-Truck (Complete)	43,000 lb
One C-Truck (Complete)	60,000 lb
One B-Truck Frame	6,050 lb
One C-Truck Frame	9,500 lb
One Swing Bolster	1,475 lb
One Spring Plank	390 lb
One Motor, Wheel and Axle Assembly	11,600 lb
Traction Motor (Less Gear Case)	7,000 lb
Air Compressor (Dry)	1,590 lb
One Battery Tray	300 lb
Engine Hood Assembly (Not Including Radiator Hood)	4,000 lb
Fan Gear Unit	860 lb
Radiator Fan	340 lb
Compressor Drive Shaft and Hubs	280 lb
Each Radiator Section	310 lb
Equipment Blower	1,106 lb
Engine and Generator (Complete)	59,845 lb
Main Generator with Auxiliaries	16,695 lb
Auxiliary Generator and Exciter	690 lb
Engine (Less Generator)	43,150 lb
Engine Component Parts	
Main Frame (Bare)	11,670 lb
Crankshaft	3,955 lb
Turbocharger	1,425 lb
Intercooler (Dry)	500 lb
Cylinder (Complete)	760 lb
Piston and Master Rod Assembly	207 lb
Piston and Articulating Rod Assembly	94 lb
Oil Pump	350 lb
Water Pump	248 lb
Control Governor	112 lb
Governor Drive Assembly	159 lb
Oil Pan	1,080 lb
Free-End Cover	1,330 lb
End Cover (Generator End)	89 lb
Exhaust Manifold	570 lb

LOCOMOTIVE DESCRIPTION

GENERAL

The General Electric railroad diesel-electric locomotive is especially designed and built to meet the requirements of modern high-speed freight traffic. The design provides for high horsepower per axle with a minimum of equipment and weight. With available modifications, the locomotive can be used in passenger service.

POWER PLANT

DIESEL ENGINE

The locomotive is powered by a 16-cylinder, four-stroke cycle, turbocharged, diesel engine with 9-inch by 10 1/2-inch cylinders in a 45-degree Vee arrangement. The engine has an integral head and cylinder arrangement which can be removed in a minimum of time. It is equipped with cast-iron pistons, valve-seat inserts and the Bendix fuel system. The cylinder liner is plated with porous chrome to give longer liner life.

GOVERNOR

The Woodward PG engine governor is of the self-contained, electro-hydraulic type. It automatically regulates the horsepower output at each throttle setting.

OVERSPEED PROTECTION

The engine is automatically shut down if the speed exceeds maximum rated rpm by 10 percent.

COOLING SYSTEM

A gear-driven centrifugal pump, integral with the diesel engine, circulates cooling water through the engine,

turbocharger, air intercoolers, self-draining radiator, lubricating-oil cooler, air compressor, and cab heater. An expansion tank is equipped with sight gages to indicate water level. The system is pressurized. Abnormally low water pressure automatically shuts down the engine.

ENGINE TEMPERATURE CONTROL

A flow-control valve, thermostatically operated, automatically maintains temperature by regulating the flow of cooling water through the radiator sections.

FUEL SYSTEM

A motor-driven pump transfers fuel from the tank, through a strainer and filters, to the injection pumps.

Each cylinder is equipped with high-pressure fuel-injection pump and injector.

LUBRICATING SYSTEM

A full-pressure system is supplied by a gear-type pump integral with the diesel engine.

A lubricating-oil reservoir is located in the engine sub-base. Lubricating-oil filters, strainer, and water-cooled oil cooler are provided. Abnormally low lubricating-oil pressure automatically shuts down the engine.

ENGINE STARTING

The diesel engine is cranked by two, 32-volt, d-c motors from storage battery power.

ELECTRIC TRANSMISSION

TRACTION ALTERNATOR

One General Electric, GTA-9, traction alternator is mounted directly on the engine. It is an alternating-current, single anti-friction bearing, separately excited machine. The output is rectified by a full-wave rectifier.

TRACTION MOTORS

General Electric, GE-752, traction motors are furnished. The traction motor is direct-current, series wound, and is separately ventilated by the cleaned-air system. The armature is mounted in anti-friction bearings.

Motors drive through single-reduction spur gearing. They are supported by the axles to which they are geared, and by resilient nose suspensions on truck transoms.

CONTROL

The locomotive is equipped with General Electric, railway-type, single-end single-unit control, and basic equipment. Control devices are grouped in a pressurized steel compartment, fitted with access doors. The reverser and line contactors are electro-pneumatically operated. Other contactors are magnetically operated. Circuit-breaker type switches are used in control circuits where overcurrent protection is required. Transition is automatic.

EXCITER

One General Electric, Type GY-27, exciter is provided. It is gear-driven from the traction generator, and provides controlled excitation of the traction generator field.

LOCOMOTIVE DESCRIPTION

BATTERY-CHARGING GENERATOR

One General Electric, Type GY-27, battery-charging generator is provided.

It is gear-driven from the traction generator, and furnishes power at regulated potential for battery charging, lighting, and control.

STORAGE BATTERY

A 32-cell, lead-acid type storage battery is furnished for starting the engine and to furnish power for lights and other auxiliaries when the engine is shut down.

WHEEL-SLIP CORRECTION

Wheel slip is automatically detected by comparison of output signals from an alternator mounted on each axle. Slip is corrected by automatic application of sand and reduction of power.

GROUND RELAY PROTECTION

If a ground occurs, the engine speed returns to idle, power is removed, the alarm bell rings, and visual indication is given to the operator.

OPERATING CONTROLS

Controls and instruments for operating the locomotive are grouped at the operator's station and at auxiliary panels in the operator's cab.

Operating Controls:

Controller with throttle reverser, and selector levers.
Engine start push buttons. Engine stop push button.
Brake valves.

Sander valve. Bell ringer valve. Air horn valve.
Window wiper.
Circuit breakers and switches.
Emergency multiple-unit engine stop button.
Emergency fuel trip.
Ground relay reset push button.

Instruments:

Air-brake gages. Load meter.

Warning Indicators:

Low engine water pressure – alarm bell and warning light.
Low engine lubricating-oil pressure – alarm bell and warning light.
High engine water temperature – alarm bell and warning light.
Wheel slip – buzzer and warning light.
Ground relay – red indicator.
Engine shutdown – alarm bell.
No battery charge – alarm bell and warning light.
Crankcase overpressure switch – alarm bell and warning light.

Some accessories and modifications may be provided to suit customer needs.

LOCOMOTIVE BRAKES

AIR BRAKES

Schedule 26L with F control-valve air equipment is furnished.

Locomotive brakes may be operated either independently or with train brakes. Connections for furnishing compressed air to the train brakes are provided at each end of the locomotive.

LOCOMOTIVE DESCRIPTION

COMPRESSOR

One, three-cylinder, two-stage, water-cooled, engine-driven air compressor furnishes air for the locomotive and train braking systems.

Compressed air displacement:

Idle engine speed . . . . . 112 cfm
Full engine speed . . . . . 282 cfm

RESERVOIRS

Reservoir capacity of 56,000 cubic inch is furnished for storing and cooling air for the brake system.

BRAKE EQUIPMENT

Brake cylinders are mounted on the truck frames, and operate fully equalized brake rigging which applies two brake shoes to each wheel.

Brake rigging is furnished with hardened-steel bushings, and adjustment is provided to compensate for wheel and shoe wear.

HANDBRAKE

A wheel-operated handbrake, located on the outside of the short hood, is provided for holding the locomotive at standstill.

RUNNING GEAR

The running gear of the locomotive consists of two, four-wheel, two-axle, side-equalized, swing-motion, swivel trucks; or two, three-axle, lateral-motion, single-center plate, swivel trucks.

LOCOMOTIVE DESCRIPTION

On the four-wheel truck frame, the bolster and the spring plank are of cast steel. The frame is supported by two equalizers on each side, with coil springs between the equalizer and the frame. Elliptic springs are applied between the bolster and spring plank. The spring plank is supported by forged-steel swing links pinned to the truck frame.

On the six-wheel truck, the frame is of cast steel. The center load is distributed by the cast-steel "floating bolster" to four rubber mounts which rest on the truck frame and provide controlled lateral motion. The truck frame is supported by alloy-steel coil springs over the journal boxes. Friction-type snubbers damp vertical oscillation.

WHEELS

Solid, multiple-wear, rim-treated, rolled steel, of 40-inch diameter. The wheels have standard AAR tread and flange contour.

AXLES

Axles are of forged open-hearth steel, conforming to AAR material specifications.

JOURNAL BOX

Journals are equipped with sealed, grease-lubricated, roller bearings. Pedestal openings of the truck frame are lined with renewable, steel, wear-resistant plates.

CENTER BEARINGS

Large center bearings are equipped with hardened steel liners, arranged for lubrication and protected by dust guards.

SIDE BEARINGS

Side bearings, with renewable wear-resistant steel plates, are provided.

SAFETY HOOKS

Body and truck safety hooks are provided to prevent slewing in case of derailment, and to permit the trucks to be lifted with the superstructure.

SUPERSTRUCTURE

The welded-steel superstructure consists of a short front hood, an operator's cab, an engine hood, and a radiator compartment. The engine hood is bolted to the underframe, and is removable.

FRONT HOOD

The front (short) hood contains a top-serviced sandbox. A door in the front bulkhead of the operating cab provides access to the inside of the hood.

OPERATING CAB

The sides and roof of the operating cab are insulated and steel lined. The floor, raised above the underframe, is insulated and covered with laminated hardboard.

The cab has safety-glass windows in the front, rear, and each side, providing visibility in all directions. Two-pane center windows on each side of the cab have a sliding sash equipped with latches. All other windows are fixed.

Doors, in diagonally opposite corners of the operating cab, provide access to walkways along the hoods. The

doors have windows, weather stripping, and provision for locking.

WALKWAYS

Platform walkways, with handrails and non-skid treads, are provided at each end of the locomotive and along the hoods.

ENGINE HOOD

The engine hood encloses the diesel engine, the traction generator, and the equipment blower.

Full-height side access doors extend the length of the engine and generator on both sides of the hood. Doors in the roof provide access to engine cylinders. Detachable roof sections permit removal of equipment.

RADIATOR COMPARTMENT

The radiator compartment contains the radiators, fan and gearbox, air compressor, and engine air cleaners. The radiators are roof mounted. A reinforced screen over the air outlet opening is removable to permit removal of the radiators and the fan and gearbox. Dynamic braking grids, when provided, are mounted along each side of the radiator compartment. An end section holds a sandbox, serviced from the roof. Rear headlights, classification lights, and number boxes are mounted on this section.

EQUIPMENT COMPARTMENTS

Main propulsion control equipment is located on the left side of the locomotive, beneath the operating cab. This compartment, maintained under positive air pressure to keep out dirt and water, contains contactors, reverser, braking switch, resistors, and auxiliary electrical devices.

All air-brake devices and air-operated equipment, and battery trays are located in easily accessible compartments along the sides of the locomotive.

VENTILATION

Mechanically filtered air is provided through self-cleaning air cleaners located in the underframe. Clean air is delivered under pressure for equipment cooling, pressurization, and cab ventilation. Engine air is cleaned by self-cleaning air cleaners and oil-bath air filters.

UNDERFRAME

The underframe is made of rolled-steel sections and plate.

Hoods, cab equipment, and tanks are supported by the main frame members. Space between these members is enclosed with plate, top and bottom, to form an air duct which distributes clean air throughout the locomotive.

WEARPLATES

Renewable, wear-resistant, hardened-steel plates are applied to the center-bearing, side-bearing pads, and draft gear housing.

COUPLERS

AAR, Type E, top-operated couplers with rubber-cushioned draft gear are provided at each end of the locomotive.

PILOTS AND SIDE STEPS

A pilot with footboards is provided at each end of the locomotive. Side steps provide access to the platform.

LOCOMOTIVE DESCRIPTION

LIFTING AND JACKING

Four jacking pads, in combination with lugs for cable slings, are integrally cast in the side bolsters.

FUEL TANKS

A heavy-gage, welded-steel fuel tank is bolted to the underframe between the trucks. Filler connections and fuel-level gages are furnished on each side of the locomotive. Emergency fuel shutoffs, clean-out plugs, and water drains are provided.

CONTROL EQUIPMENT

INTRODUCTION

Most of the locomotive control-equipment devices are located in the pressurized steel compartment under the left side of the operator's cab. Access to these devices is from outside the locomotive. See Fig. 3-1.

The power contactors, reverser, and braking switch are electro-pneumatically operated. The other contactors and relays are magnetically operated. The voltage regulator, wheel-slip panel, and automatic transition panel are statically operated.

The control equipment consists of the following devices:

1. Master Controller
2. Relays
3. Contactors
4. Reverser and Braking Switch
5. Magnet Valves
6. Interlocks
7. Alternator
8. Static Panels
9. Control Switches

MASTER CONTROLLER

INTRODUCTION

The master controller is a set-up switch used by the operator to control the locomotive. See Fig. 3-2.

It has a Reverser handle to set up the circuits for FORWARD or REVERSE motor operation, a Selector handle to set up circuits for the operation of motoring and to initiate dynamic-braking circuits, a Throttle handle to set up the circuits to control engine speed and power or, alternatively, the amount of dynamic-braking effort desired.

The opening and closing of cam-operated contacts is controlled by positioning each handle for the desired op-

CONTROL EQUIPMENT

NOMENCLATURE FOR FIG. 3-1

1 Control relays
2 Transition panel
3 Ground relay cut-out
4 Excitation panel
5 Wheel-slip panel
6 Ground relay
7 Dynamic-braking cut-out
8 Voltage regulator
9 Power matching panel
10 Power contactors
11 Reverser
12 Starting resistors
13 Starting contactors

eration. When the handles are positioned for the desired operation, they control the power devices remotely, and select the desired load and governor setting for the engine.

Various control switches, circuit breakers, and indicating lights are mounted on the housing of the controller.

Mechanical interlocking between the handles prevents the improper operation of any handle. See INTERLOCKING BETWEEN HANDLES.

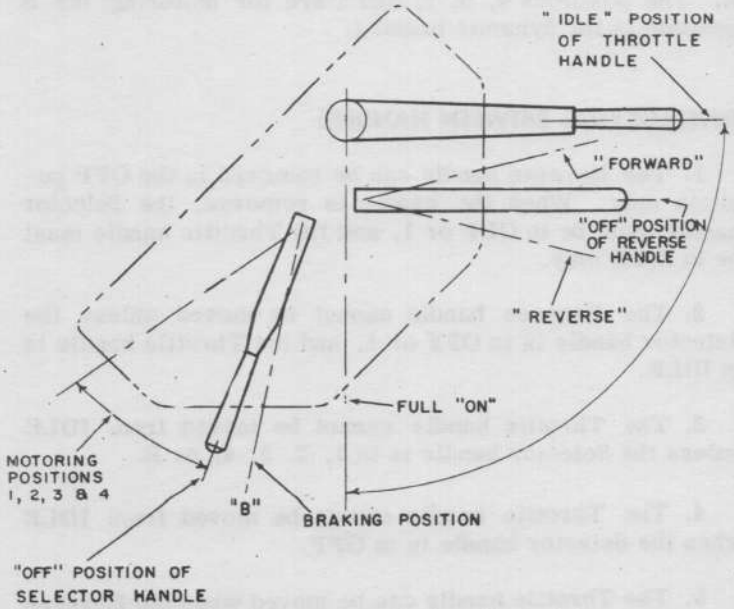


Fig. 3-2 (E-10102A)

Fig. 3-2. Master-controller handle positions

6. The Selector handle cannot be moved into B (braking) unless the Throttle handle is in IDLE, and the Reverse handle is in FORWARD or REVERSE.

INSPECTION AND MAINTENANCE

1. See that full contact is obtained across and between contact-finger surfaces. For tip gap, see DATA.

2. Dress the silver-faced contacts as required. File the surfaces smooth, using a fine ignition-point file. Do not use sandpaper or emery cloth, to avoid embeding abrasive particles in contact surface.

3. Resharpen any worn serrated contact surfaces with a small triangular file. Do not bend the contacts when filing or cleaning.

4. Renew the contacts when the silver facing is worn through.

5. Check the wiring according to schematic diagram.

6. Check the handle movement according to instructions under INTERLOCKING BETWEEN HANDLES.

DATA

Contact Fingers	No. Fingers	Tip Break (32nd Inch)	Overtravel (32nd Inch)	Final Pressure (In Pounds)
Reverse	4	11-13	3-4	3/4 - 1
Throttle	14	11-13	3-4	3/4 - 1
Selector	10	11-13	3-4	3/4 - 1

HR (Type 17LV66J10) - Used to indicate that the battery is not being charged or that the auxiliary generator voltage is below battery voltage.

MR (Type 17LV66J10) - Used to give 16 notches of excitation in motoring and dynamic braking. When the General Electric unit is trailing a unit of another manufacture, MR does not pick up and its contacts set up excitation in motoring and dynamic braking to correspond to the lead unit.

PCR (Type 17LV66J10) - Used as the power-control relay, it sets up the circuits from the PC wire for the governor-speed solenoid valves.

WSR (Type 17LV66J10) - Used to set up the circuits to correct and give an indication when a wheel slip occurs.

TTD (Type 1200-36R-48) - Prevents false parallel transition, at speeds below normal, due to wheel slip.

CONTACT MAINTENANCE (17LV66 AND LV68)

The contact-tip break will become progressively greater with time and use of the relay. As the break increases, the tip overtravel decreases. Therefore, periodic inspection and adjustment of the fixed contacts becomes necessary to check and restore normal tip break and overtravel. If silver contact tips have worn or burned through, or if experience shows tips will be worn through prior to the next inspection period, replacement of contacts is necessary.

SPECIAL TOOLS (17LV66 AND LV68)

1. Contact Adjuster, Catalog No. 336B440P5
2. Contact Overtravel Gage, Catalog No. 336B440P7

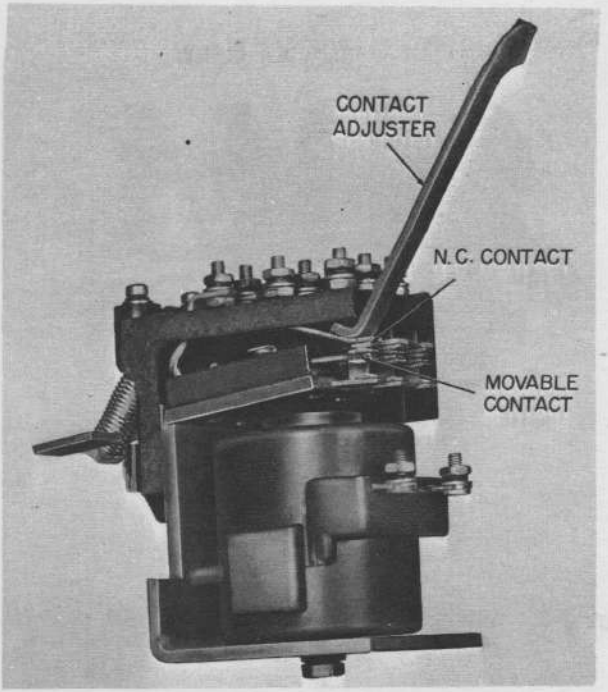


Fig. 3-4 (E-8411A)

Fig. 3-4. Adjusting normally closed contacts

2. Block the armature of the closed relay to hold the gage in place.

3. Using the contact-adjuster gage, bend normally; open the contacts at right angles, using the contact adjuster, as shown in Fig. 3-6, until a 0.003-inch gap is obtained between all contacts. Use a 0.003-inch feeler gage for checking gap.

4. Remove the gages and blocking from the relay and operate the armature by hand. See that all contacts make at the same time.

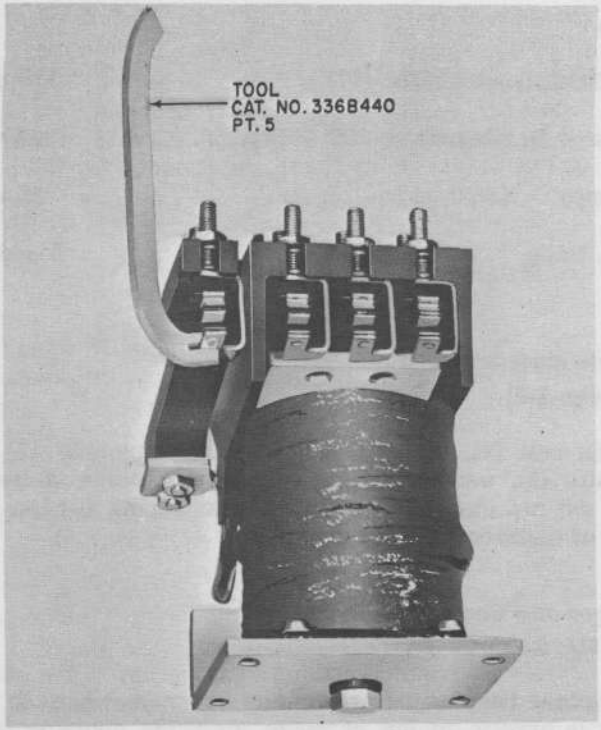


Fig. 3-6 (E-5607A)

Fig. 3-6. Adjusting normally open contacts

ADLAKE RELAY

Introduction

Type 1200-36R-48 Adlake relays are a mercury-plunger form of the time-delay relays used for control circuit interruption. The relay consists of a coil, mercury plunger, contact assembly, and resistor.

The mercury plunger is a dampening device which enters a time-delay period of contact pickup after the coil has been energized. See the following DATA for the time-delay period.

contactor and plunger assembly can be removed from inside the defective coil, and can be used with the replacement coil.

Resistor Replacement

Replace the resistor when its ohms are plus or minus 10 percent of the value given in the DATA section.

CONTACTORS

INTRODUCTION

The contactors used on the locomotive are remotely controlled devices used for repeatedly opening and closing an electric power circuit.

The contactors used on the locomotive usually consist of a pair of main contacts, a coil which initiates operation, and a blow-out coil to supply the arc-extinguishing force. On electro-pneumatic contactors, the coil is replaced with an air cylinder and magnet valve to initiate the operation of the contactor.

In some instances, auxiliary contacts called interlocks are mounted on the contactor and operate in conjunction with the main contacts.

The following tabulation lists the different contactors by symbol, type, and use in the locomotive electrical circuit:

FS1, 2, 3, 4 (17CM55J3) - Used to shunt the traction-motor fields. Each contactor has two pair of main contact tips.

GF (Type 17CM55N3) - Used to connect the suicide and stabilizing circuit to the main-generator field.

Fig. 3-9 (E-1328D)

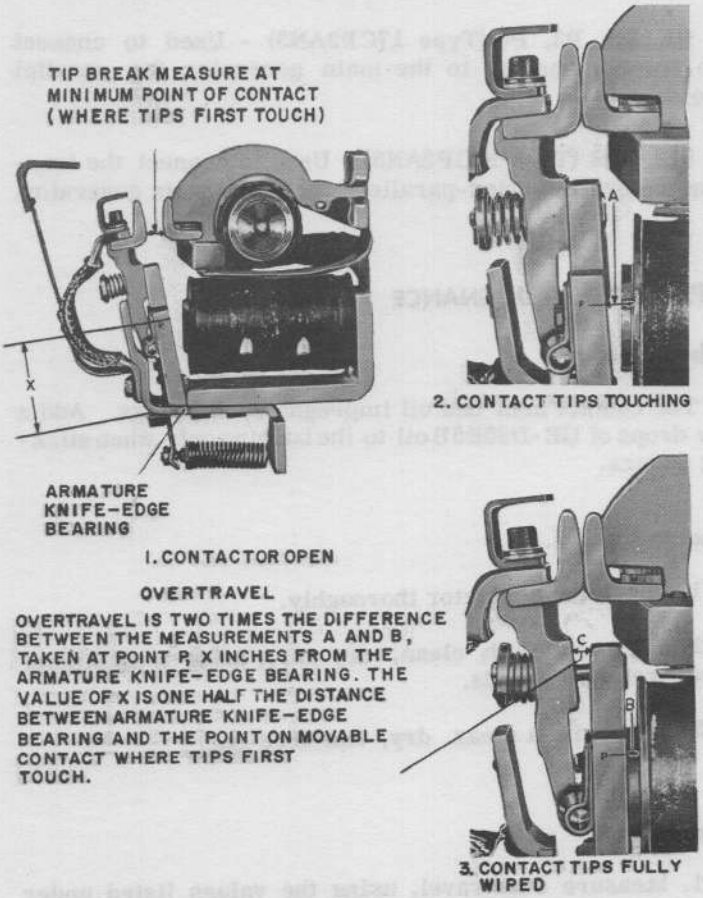

TIP BREAK MEASURE AT MINIMUM POINT OF CONTACT (WHERE TIPS FIRST TOUCH)
X
ARMATURE KNIFE-EDGE BEARING
1. CONTACTOR OPEN
A
P
2. CONTACT TIPS TOUCHING
OVERTRAVEL
OVERTRAVEL IS TWO TIMES THE DIFFERENCE BETWEEN THE MEASUREMENTS A AND B, TAKEN AT POINT P, X INCHES FROM THE ARMATURE KNIFE-EDGE BEARING. THE VALUE OF X IS ONE HALF THE DISTANCE BETWEEN ARMATURE KNIFE-EDGE BEARING AND THE POINT ON MOVABLE CONTACT WHERE TIPS FIRST TOUCH.
C
B
P
3. CONTACT TIPS FULLY WIPED

Fig. 3-9. Measuring tip break and overtravel

c. Bent magnet frame

3. High overtravel may be caused by, or is an indication of:

a. Bent tips

b. Worn stop on contact lever

c. Bent or grooved armature stop

d. Bent magnet frame

Tip Break

1. Measure tip break at the point of minimum spacing when the tips are open. Use the values found under DATA for specific contactor, and take into account that these values are for new tips. Refer to Fig. 3-9.

2. Variations in tip break may be caused by, or are indication of:

a. Worn or bent contact tips

b. Bent armature stop

c. Worn or bent contact lever

Tip Alignment

Check the tips for misalignment which may be caused by, or is an indication of:

1. Grooving or uneven wear of the armature stop

2. Rounded knife edge or uneven wear of the armature

3. Grooving or uneven wear of the armature guide

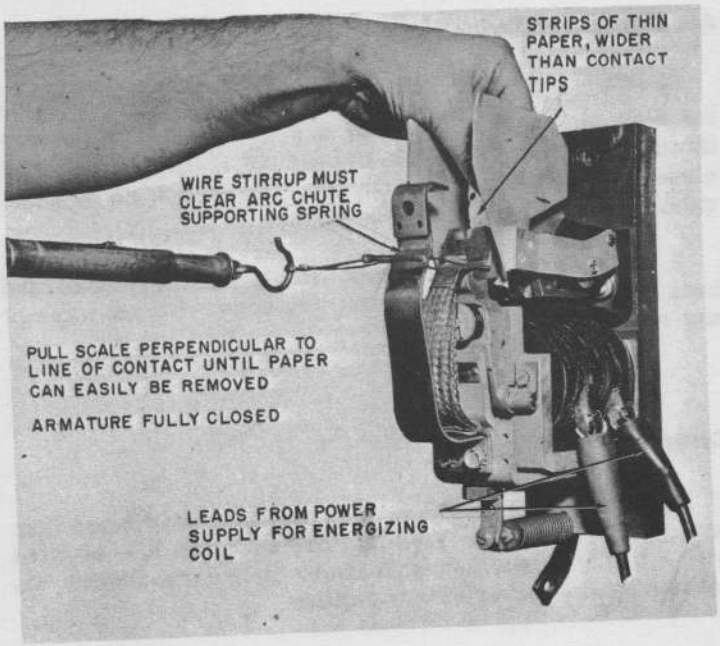

STRIPS OF THIN PAPER, WIDER THAN CONTACT TIPS
WIRE STIRRUP MUST CLEAR ARC CHUTE SUPPORTING SPRING
PULL SCALE PERPENDICULAR TO LINE OF CONTACT UNTIL PAPER CAN EASILY BE REMOVED
ARMATURE FULLY CLOSED
LEADS FROM POWER SUPPLY FOR ENERGIZING COIL

Fig. 3-10 (E-1464B)

Fig. 3-10. Measuring final contact tip pressure

sure need not be checked providing the air cylinder is operating properly and the air pressure is at the operating pressure.

3. Causes of incorrect tip pressure are:

   a. Defective contact pressure spring, worn spring seat or washers, or worn stop, indicating low initial tip pressure.

   b. Defective contact pressure spring, or low overtravel, indicating low final pressure.

   c. Use of the wrong contact pressure spring, indicated by a rare high pressure.

Coils

1. Check the resistance of coil against values indicated in DATA. Renew the coil when measured values are not within plus or minus 10 percent of those shown.

2. Check the coil terminals. If damaged, renew the coils.

3. Check the insulation. If the insulation is dry, damaged, or brittle, reinsulate the coils and parts with GE-A15E19B or GE-A15B17A varnish.

Calibrating Spring

Replace any springs which are cracked, corroded, notched on end hooks, have lost tension, or do not allow correct pick-up to set.

Contact-pressure Spring

Replace the spring if the initial or final pressure is low, or if the spring is cracked, corroded, notched, or has lost tension.

Electro-pneumatic Contactor Check

1. With air supply on locomotive, depress the magnet-valve armature to close the armature. Release the magnet-valve armature to open the contactor; the contactor tips should part and come to the fully open position without any hesitation.

2. Operate the contactor several times to see that the main contacts touch before the normally open interlock contacts touch, and that the normally closed interlock contacts open before the main contacts touch.

Type 17CM57A9A

Resistance at 25C	185.0 ohms
Current to Operate	0.195 amp
Current Continuous	0.309 amp

Type 17CM55J3

Resistance at 25C	116.0 ohms
Current to Operate	0.345 amps
Current Continuous	0.510 amps

REVERSER AND BRAKING SWITCH

INTRODUCTION

The Type DP13 or DP14 reverser is an electrically controlled power switch which connects traction-motor fields for either FORWARD or REVERSE motor (armature) rotation.

When the Reverse lever on a controller is moved to either the FORWARD or REVERSE position, the corresponding interlock on the reverser closes to activate either the forward or reverse magnet valves. In turn, magnet valves operate main reverser contacts to switch the traction-motor fields to correspond with the position of the Reverse lever.

The reverser consists of the following main parts: main contacts, interlocks, magnet valves, and air cylinders. These main parts, along with other components, are mounted on a metal frame. Frame legs have special mounting feet so the reverser can be bolted in position.

The GP19 braking switch is an electrically controlled power switch which connects braking grids across the traction motors (armatures) and sets up dynamic braking on the locomotive. This switch is similar in appearance and operation to the DP13 or DP14 reverser.

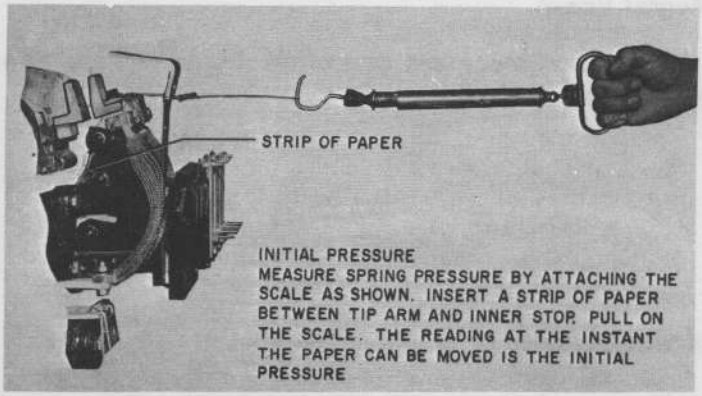

STRIP OF PAPER
INITIAL PRESSURE
MEASURE SPRING PRESSURE BY ATTACHING THE SCALE AS SHOWN. INSERT A STRIP OF PAPER BETWEEN TIP ARM AND INNER STOP. PULL ON THE SCALE. THE READING AT THE INSTANT THE PAPER CAN BE MOVED IS THE INITIAL PRESSURE

Fig. 3-11 (E-3513A)

Fig. 3-11. Measuring initial pressure

6. See that the edges of mating contacts are not more than 1/16 inch out of alignment when the contacts are closed.

7. See that all contacts close in such a manner that no contact closes in advance of any other by more than 3/64 inch.

DATA

Main Contacts

Tip Break	11/16 to 13/16 inch
Overtravel	7/32 to 9/32 inch
Pressure	35 to 45 lb

Interlocks

Tip Break	1 - 1-3/16 inch
Overtravel	2/16 to 3/16 inch
Pressure	3/4 to 1-1/2 lb

3. To check the valve for cleaning or inspection:

   a. Remove the cap plug and copper washer from the bottom of the valve body and remove the inlet valve stem and spring.

   b. Remove the armature guide and armature to release the exhaust valve stem.

   c. Clean the ports, valve seats, valve stems, and spring.

4. If the valve ports leak air after cleaning, replace the valve. Do not scrap the valve; it is repairable in back shop.

DATA

Type 17MV34B6

Resistance at 25C	775 ohms
Current to Operate (At 90-psi air pressure)	0.069 amp
Current Continuous	0.133 amp
Voltage Continuous	135 volts

Type TE-49-FF2

Resistance at 25C	299 ohms
Current to Operate (At 125-psi air pressure)	0.119 amp
Current Continuous	0.243 amp
Voltage Continuous	94.5 volts

mounting plate. Overtravel is the distance the contact bar travels after the contact fingers first touch.

6. Adjust type 17AF21 interlocks for correct tip break and overtravel by moving the stationary-contact screws.

7. Inspect the cam block for any foreign matter. This block must be free of all grease, oil, dirt, and must be smooth. If the cam block is deeply grooved so that proper break and overtravel cannot be obtained, replace the cam block.

NOTE: *Thoroughly clean the interlock; these devices should never be lubricated.*

8. See that the movable-contact fingers have pressure on the cam block at all times. When the interlock contacts are in their open position, the pressure should be just enough that the finger does not vibrate when it is moved away from cam block and snapped back into position.

DATA

Type 17AF14

Tip Break	7/32 to 9/32 inch
Overtravel	3/32 to 4/32 inch
Pressure	8 oz minimum

Type 17AF21

Tip Break	3/32 to 5/32 inch
Overtravel	1/16 inch
Pressure	1 to 2 lb

Type 17AF41

Overtravel	3/32 to 4/32 inch
Pressure	4 oz minimum

CONTROL EQUIPMENT

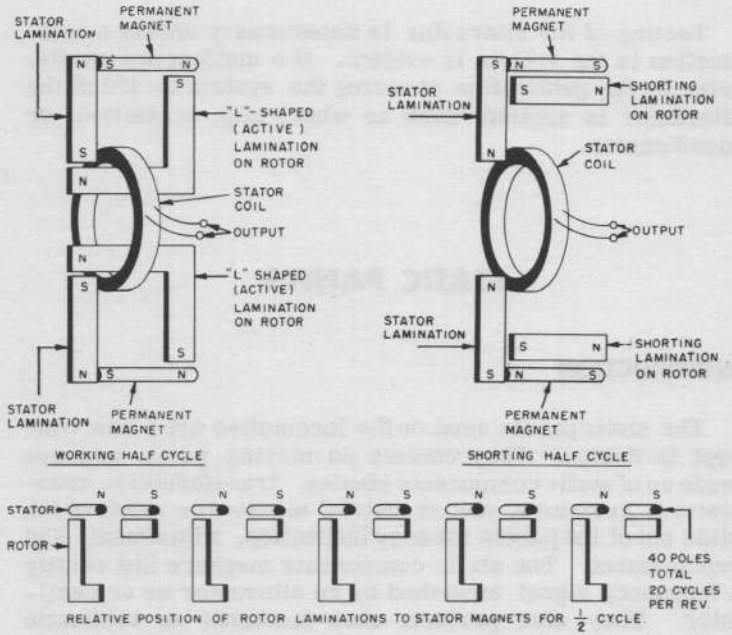


Fig. 3-12 (E-8957)

Fig. 3-12. Magnetic circuits of alternator

INSPECTION

At routine inspection periods, wipe off the outside of the alternator and inspect the leads and connections to be sure that no damage has occurred where the leads come out through the terminal box.

LUBRICATION

Bearings are permanently sealed in grease and require no maintenance or lubrication.

CONTROL EQUIPMENT

ADHESION-LOSS DETECTION (17FL7 AND 17FL8)

Introduction

The FL7 or FL8 panel is a group of removable static-component cards which detect loss of adhesion between the wheel and the rail. When adhesion loss occurs between locomotive wheels and the rail, this panel signals the operator and automatically starts corrective action. The component cards plug into a metal housing.

A frequency signal proportional to the axle speed is sent to the panel from an axle-driven alternator mounted on the axle. This signal is rectified, measured, and compared by semiconductor components in the panel. If the signal from one of the axle-alternators is greater or less than the other alternators (by a predetermined amount), corrective action starts automatically.

Because this system functions whenever a difference in voltage occurs between the individual alternator circuits, a faulty component may also cause (by changing voltages in the system) corrective action to take place. A malfunction may also cause the panel to be inoperative or less sensitive. Should a malfunction occur, refer to the TROUBLE SHOOTING section to locate the faulty axle-alternator circuit.

A description of the main parts and their functions are included in the following paragraphs. See Fig. 3-13 for the schematic diagram of the 17FL7 adhesion-loss panel.

Axle Card (180)

The components mounted on this card perform the following functions:

1. They measure the axle-alternator frequency of two axles, and convert the frequency signal to an output d-c voltage.

2. They compare the output voltage (proportional to the speed of the axle-alternator connected to the card) with the outputs of the other alternators.

3. The synchronous-slip circuit causes a slip indication when the synchronous speed of the motors reaches a predetermined value. There are two separate circuits which may be connected. The one used will be determined by the locomotive gearing.

Axle and Sensing Card (182)

Components mounted on the Axle and Sensing Card perform the following functions:

1. They measure axle-alternator frequency of one axle and convert the frequency to an output d-c voltage.

2. They compare the output voltage (proportional to the speed of the axle-alternator connected to the card) with the outputs of the other axle-alternators that are connected to the other cards.

3. They provide slope adjustment so the system is not as sensitive at high speed as it is at low speed.

4. They start corrective action.

Sensitive-relay Card (183)

The 183 card contains components to divide the control voltage to safe values for the semiconductors. In addition, the card performs the following functions:

1. Diode RD21 and capacitor C9 provide spike protection against transient voltages that may appear outside the panel.

CONTROL EQUIPMENT

Test Equipment Required

The following test equipment is required to repair, maintain, and test the Adhesion-loss Detection panel.

1. Simpson Meter, Model No. 260, or equivalent (Meter must read 120 microamperes or lower).

2. Test Set, Type MM28 or Type MM37.

3. Battery, 22.5 volt, Eveready, No. 762-S, or equivalent.

4. Battery, Size D

5. Resistor, 2500 ohm, 1 watt

6. Resistor, 2000 ohm, 1 watt

7. Resistor, 500 ohm, 1 watt

Trouble Shooting

The trouble-shooting instructions that follow are to be used to help locate a failed card or component if the adhesion-loss detection panel is not functioning properly. Also included are instructions for the adjustment of the panel after repair of cards or replacement of components. Cards can be interchanged without readjusting the panel.

CAUTION: *ADJUSTMENT OF RHEOSTATS OR POTENTIOMETERS ON ANY CARD IN THIS PANEL CANNOT BE MADE WITHOUT AFFECTING THE BALANCE OR SENSITIVITY OF THE PANEL. SHOULD REPLACEMENT OR ADJUSTMENT OF ANY RHEOSTAT BE NECESSARY, IT CAN BE CORRECTLY REBALANCED TO BE IDENTICAL TO FACTORY BALANCE USING THE MM37 TEST SET, SO THAT IT CAN BE OPERATED WITH OTHER PROPERLY BALANCED CIRCUITS.*

the secondary from the saturating transformer in the wheel-slip panel. If the slip indication stops, consult the instruction on the transition panel.

3. Using the MM37 test kit as an input source to the panel (the card extender enclosed in the kit must also be used), measure the voltage drop across all the rectifying diodes individually (RD1, RD2, RD33, and RD34). All voltage drops should be similar. A lower voltage drop on any of the diodes might indicate a diode which breaks down with voltage applied; this cannot be determined with a Simpson meter.

4. Shorted Synchronous-slip Transistor

Remove the 181 card and, with a Simpson meter on the R X 1 scale, check for a shorted synchronous-slip transistor between Pin A and Pin 28. If the transistor is shorted, repair or replace the card.

5. Shorted Synchronous-slip Reference Diodes

Remove the 181 card and, with a Simpson meter on the R X 1 scale, check for shorted diodes between the following points: Pin K and Pin 62, Pin 62 and Pin 51, Pin J and Pin 62. If any of the diodes are shorted, repair or replace the card.

6. Shorted Anticipation Capacitor

Remove the wire connected to TBX. This will disconnect the anticipation capacitor (if used). If the indication stops, the capacitor is most likely shorted. Replace the capacitor.

If the trouble is not indicated in the panel circuits, check the axle-alternator circuits as follows:

a. Measure the resistance of each alternator circuit by connecting a Simpson meter across leads A and B, D and C, F and E, and H and G. The resistance between each pair of leads should be 73 to 83 ohms.

b. If the resistance is within these limits, check the alternators. Remove each alternator and inspect the axle drive. The rubber coupling assembly should be free of any cracks and should not have any radial movement before turning the rotor. The spade should fit in the axle with a minimum amount of radial clearance. If any of these defects are found, repair or replace the defective part or parts. On locomotives using "AP" bearings, make sure the large nut on the end of the bearing is tight.

If a slip indication occurs with the locomotive at a standstill with the battery switch closed and the axle-alternators connected (but not rotating), make the following checks:

1. Shorted Wheel-slip Transistor

Remove the 182 card and, with a Simpson meter on the R X 1 scale, check for a shorted wheel-slip transistor. Connect the meter between Pin K and Pin F. If the transistor is shorted, repair or replace the card.

2. Check the wheel-slip relay WSR (relay external to the panel) to be sure it is de-energized.

3. Shorted Sensitive-relay Contacts

Remove the 183 card and measure the resistance from Pin J to Pin K. It should be infinite resistance. This reading indicates that the normally open contacts are not shorted. If the contacts are found to be shorted, replace the relay.

4. Wheel-slip Transistor Leaking

Remove the wire from TBAD and insert a Simpson meter (100-milliampere scale) between terminal point TBAD and the wire removed from the stud. The leakage should not be more than 20 microamps (if reading on 100-milliampere scale is zero, move progressively to a lower scale).

zero. If the voltage does not drop to zero, check the wheel-slip transistor to be sure it is being turned on.

6. Connect a voltmeter across the panel from TBAB (+) to TBL (-). With the test set turned off, the voltage should be from 20 to 25 volts. When the test set output is increased, the voltage should drop to zero. If the voltage does not drop, replace the transistor or the card. If the voltage does drop to zero, replace the 183 card or the relay on the 183 card.

Wheel-slip Relay Operating Without Power Reduction (On Locomotives Equipped with Electric Power Modulation)

To check the power-reduction circuits, proceed as follows:

1. Set the engine-control circuits for motoring. With the engine running, the isolation switch in the RUN position, the Reverse handled centered, and the generator-field switch closed, run the engine to notch 3.

2. Connect a voltmeter across main generator TBBA (+) to TBBE (-) on the excitation panel and short TBAB and TBL on the wheel-slip panel. Main generator voltage should decrease. If the voltage does not decrease, check the following:

a. Check continuity of the circuit between TBAB (on wheel-slip panel) and TBR (on the excitation panel).

b. Check the continuity of the circuit between TBAD (wheel-slip panel) and TBP (excitation panel).

If the continuity is all right, see items under SLIP WITHOUT CORRECTION. If the trouble still exists, change out the 188 card on the excitation panel.

CONTROL EQUIPMENT

Fig. 3-14 (E-13326)

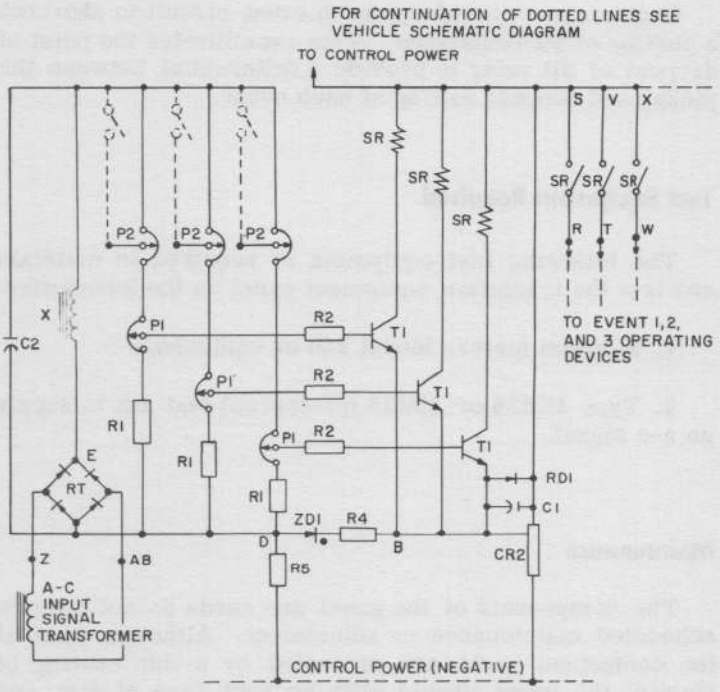


Fig. 3-14. Transition equipment panel

This d-c signal voltage is applied to each No. 210 card. The circuit continues through P2 rheostat, a portion of P1 rheostat, R2 resistor, base-to-emitter of T1 transistor, resistor R4, five-volt zener diode ZD1 and back to the bridge rectifier (RT). P1 rheostat must be set correctly for the event programmed so that the voltage across T1 transistor (emitter to base) will be five volts (the voltage at which ZD1 will conduct). When ZD1 conducts and turns T1 on, a circuit is completed from the locomotive control power (positive), through the coils of sensitive relay (SR), the collector to emitter of T1 transistor, and through CR2 resistor back to the negative side of the control power.

Trouble Shooting Panel on Locomotive

The following instructions provide the necessary information for trouble shooting the panel on the locomotive.

Before assuming the panel components have failed, check the a-c signal voltage input to the panel. Also, check the operation of events dependent upon the panel; check as follows:

1. Disconnect the speed-sensing alternator leads going to the input of the transformer. Be sure the resistance of the alternator winding is 73 to 83 ohms at 25 C (77 F).

2. Disconnect the speed-sensing alternator leads from the primary of the a-c input signal transformer (transformer may be part of another panel or a separately mounted device) and connect the 17MM26 or 17MM28 test-set output leads to the primary.

3. Place the a-c voltage leads of the test meter across the secondary winding of the signal transformer (terminals AB and Z, Fig. 3-14). Slowly increase the input signal from the test set and note the increase in voltage shown on the meter. If no secondary voltage is indicated, check the continuity of the transformer windings.

4. Apply locomotive control power to the panel at the terminals shown on Fig. 3-14. Use the test meter; set it on the appropriate d-c voltage scale, and check operation of each event as follows:

NOTE: *The speed at which each event operates is given on the locomotive schematic diagram.*

a. Place the meter leads across panel terminals W and X.

b. Increase the test-set frequency and note operation of SR relay (relay picks up) when the event operates (test-meter reading goes to "O").

Adjusting Panel on Locomotive

Use the following instructions to adjust the rheostats on the No. 210 card. The adjustment should be made when installing a new card or when installing one which has been repaired. Adjust the card for the specific event (event 1, 2, or 3) that is indicated by the panel slot in which the card has been inserted. Each slot is marked for the event. For example, 210-1 (first event), 210-2 (second event) and 210-3 (third event). Adjust as follows:

1. Disconnect the leads going to the primary of the signal transformer and, in their place, connect the leads from the test set.

2. Apply control power to the panel terminals as shown in Fig. 3-14.

3. Set each event by placing the test-meter d-c voltage leads across the SR relay panel terminals (event 1: R and S), (event 2: T and V), event 3: W and X).

4. Adjust the test set for the event (cycles or frequency) given on the locomotive schematic diagram.

5. Adjust the P1 rheostat on the card so that its SR relay will operate at the required frequency or rpm. When the test-meter needle drops to "O", the SR relay has operated.

6. Increase the test-set frequency; then decrease and adjust the P2 rheostat for the dropout differential designated on the schematic diagram. Lock the P1 and P2 rheostats.

7. Check the accuracy of the rheostat settings by varying the output of the test set and observing pickup and dropout of SR relay. Re-adjust the rheostats, if necessary.

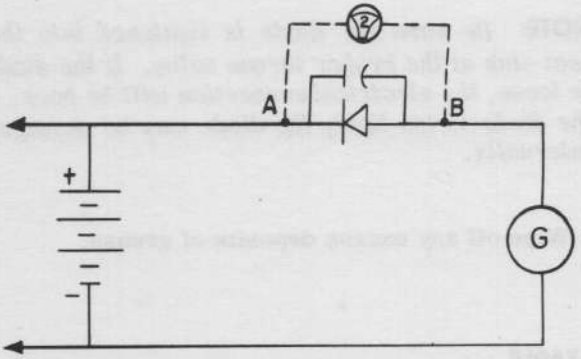


Fig. 3-15 (E-13327)

Fig. 3-15. Testing circuit, FM203 panel

1. Connect the ohmmeter leads at points A(-) and B(+). The resistance of the diode should read 15 ohms minimum.

2. Connect the ohmmeter leads in reverse of step 1, A(+) and B(-). It should read infinite resistance in this direction. If the forward or reverse resistance values are not within the above limits, remove the diode from the heat sink and install a new diode.

Replacing Silicone Rectifier (Diode)

1. Clean the surfaces of the heat sink and diode where they join.

2. Apply Penetrox* grease to the cleaned surfaces of the sink and diode.

3. Insert the diode into the heat sink and tighten to the torque value as shown in DATA TABLE.

*Burndy Corp., Norwalk 2, Conn.

CONTROL EQUIPMENT

STATIC VOLTAGE REGULATOR (17FH20)

Introduction

The FH20 voltage regulator is an automatic voltage- and current-controlling panel that controls and regulates the output of an auxiliary generator for use as battery charging and control or auxiliary power.

The voltage regulator consists of a panel which houses two plug-in type cards, an externally adjustable rheostat, a fuse, relay, and diodes and capacitors.

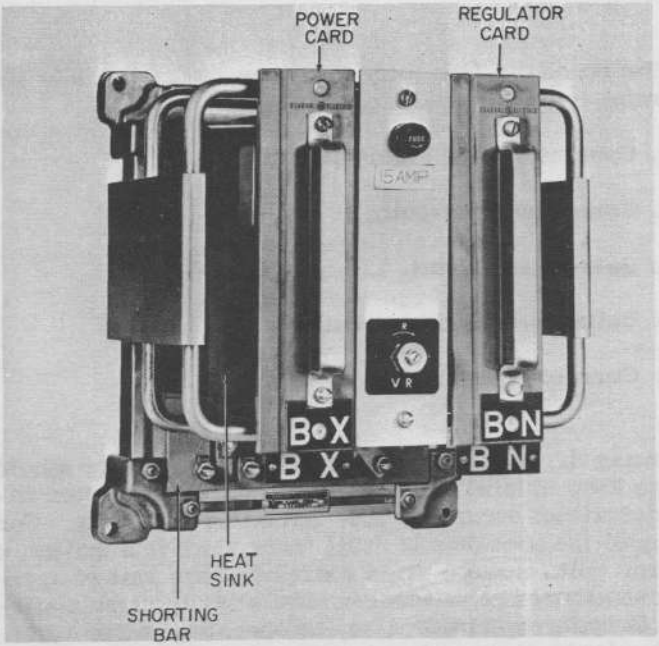


Fig. 3-16 (E-10803)

Fig. 3-16. Voltage regulator, Type 17FH20

Magnet Valves

For maintenance and data of the magnet valves, refer to MAGNET VALVES.

MAGNET VALVES

INTRODUCTION

Magnet valves are magnetically operated devices used to control the flow of air pressure to pneumatically operated devices, such as power contactors, power switches, sanders, compressor unloader valves, etc.

The core of the magnet valve rests against an air valve stem. The stem is moved by the armature to open the air valve when the coil is energized. A spring pushes the valve stem closed and opens the exhaust port when the magnet valve is de-energized. This type of valve is called an "ON" type valve. An "OFF" type valve closes the air valve when the coil is energized.

INSPECTION AND MAINTENANCE

1. Test the valve operation by depressing the armature on top of the magnet valve. Sticky valves indicate cleaning is necessary, or that valve seats are not seating properly.

2. With air pressure connected to the valve, apply soapy water to the pipe connections and the exhaust ports to test for leaks. Check the valve for leaks with the armature depressed and released. Tighten any leaky connections and if the exhaust ports leak air, disassemble the valve for cleaning and inspection of the valve seats.

CONTROL EQUIPMENT

When the Selector handle on a controller is moved into the BRAKING position, electrical circuits cause the main contacts on the braking switch to close. This, in turn, completes a circuit to place resistance across the traction-motor armatures to slow down or stop the locomotive.

The principal parts of the braking switch are the main contacts, interlocks, magnet valves and the air cylinder. These parts, along with other component parts, are mounted on a metal frame. This frame has special mounting feet on the legs so the switch can be bolted in place.

INSPECTION AND MAINTENANCE

1. Check and maintain the tip break, overtravel, and pressure of contacts and fingers.

2. See that the low-voltage interlocks make before the main contacts. Also, see that the interlock contacts make at the same time.

3. See that the low-voltage interlocks break before the main contacts. Interlocks are so designed to make and brake before the main contacts, to insure that the main contacts do not make or brake under power.

4. Check the operation of the reverser and braking switch at intervals, by depressing the armature of the magnet valve. Sluggish operation may indicate:

   a. Dry cylinder walls or leaking piston packing. If this condition is evident, add several drops of GE-D50E5B oil to the cylinder walls.

   b. Sticking or leaking magnet valves. Check the valves for air leaks, using a solution of soapy water.

5. Check for air leaks on piping joints and magnet valves, using a soapy water solution.

CONTROL EQUIPMENT

DATA

Contact Tips

Type 17CM53E10A

Tip Break	15/32 to 18/32 inch
Overtravel	10/32 to 12/32 inch
Initial Pressure	2 to 4 lb
Final Pressure	5 to 8 lb

Type 17CM57A9A

Tip Break	14/32 to 16/32 inch
Overtravel	8/32 to 10/32 inch
Initial Pressure	1 to 2 lb
Final Pressure	1.5 to 3 lb

Type 17CM55J3

Tip Break	15/32 to 18/32 inch
Overtravel	10/32 to 12/32 inch
Initial Pressure	4 to 6.5 lb
Final Pressure	12 to 16 lb

Type 17CP2AN3

Tip Break	17/32 to 21/32 inch
Initial Pressure	10 to 19 lb

Coils

Type 17CM53E10A

Resistance at 25C	25.2 ohms
Current to Operate	1.015 amps
Current Continuous	1.03 amps

CONTROL EQUIPMENT

Arc Chutes and Arcing Horns

1. Inspect the arc chutes. Repair or replace them if the side plates on arc chutes are burned 3/4 of the way through. Renew the fiber end pieces if they are burned close to the rivets. Use GE-No. 12G compound or equivalent for repairs to the side plates.

2. Inspect the arcing horns. Replace if they are burned back more than 1/8 inch from any edge. Do not attempt any repairs.

Contact Tips

Replace the contact tips when they are worn more than one-quarter through. Tips that are not worn may be filed with a fine mill file cleaned to make them serviceable. Do not use sandpaper or emery cloth.

Control Lever

1. Inspect the bushing in the contact lever. If the inside diameter is worn beyond 0.197 inch, replace the bushing.

2. Inspect the hinge pin that holds the contact lever to the armature assembly. Replace the pin if it is scored or burned.

Shunt

Check the shunt, including sleeves, for wearing, fraying, discoloring, or stiffness. Replace the shunt when any of these conditions are found.

NOTE: *(a) Allowable side-to-side misalignment when the tips are the same size is 1/16-inch overhang of the top tip on either side of the bottom tip. Heels of the contact tips must always be even.*

(b) When the top tip is narrower than the bottom tip, the top tip must not extend over edge of the bottom tip. Heels of the contact tips must be even.

(c) If conditions 1, 2 and 3 have been corrected, the tips may be re-aligned by loosening the screws holding the magnet frame and stationary contact tip support to the base, and moving the assemblies until the tips line up properly. On 17CP2 contactors, loosen the air cylinder to line up the contact tips.

Tip Pressure

1. Measure the tip pressure, as shown in Fig. 3-10. See values under DATA for specific contactor.

a. Measure the initial pressure by blocking the armature so that the contacts nearly touch. Initial pressure is the amount of pressure required to just move the contact tip arm against the contact pressure spring.

b. Measure the final pressure, as indicated in Fig. 3-10. Insert a thin strip of paper (wider than the tips) between the tips. Either energize the coil to close the armature or block the armature in the closed position and attach a stirrup with spring balance. The reading shown the instant the paper can be moved is the final pressure.

2. Measure the initial spring pressure on type 17CP2 contactors, as shown in Fig. 3-37. Final spring pres-

GS(+), GS(-) (Type 17CM53E10A) - Used to connect the starting motors to the battery for engine starting.

P1, P2, P3, P4 (Type 17CP2AN3) - Used to connect the traction motors to the main generator for parallel operation.

S13, S24 (Type 17CP2AN3) - Used to connect the traction motors in series-parallel across the main generator.

REPAIR AND MAINTENANCE

Lubrication

The contact arm has oil impregnated bushings. Add a few drops of GE-D50E5B oil to the bushing only when sticking occurs.

Cleaning

1. Clean the contactor thoroughly.

2. Blow out with clean, dry air, using a maximum pressure of 70 pounds.

3. Wipe with a clean, dry, lint-free rag.

Overtravel

1. Measure overtravel, using the values listed under DATA for the specific contactor. Refer to Fig. 3-9.

2. Low overtravel may be caused by, or is an indication of:

   a. Badly worn, bent, or incorrect tips

   b. Bent stationary contact-tip support

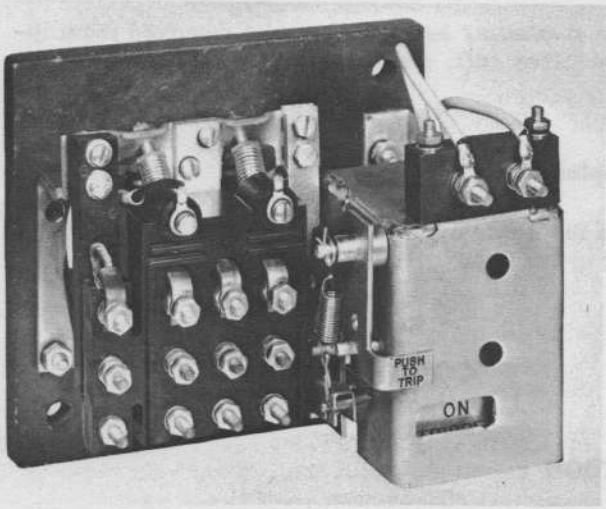


Fig. 3-7 (E-13330)

Fig. 3-7. Type 17LV67C2 ground relay

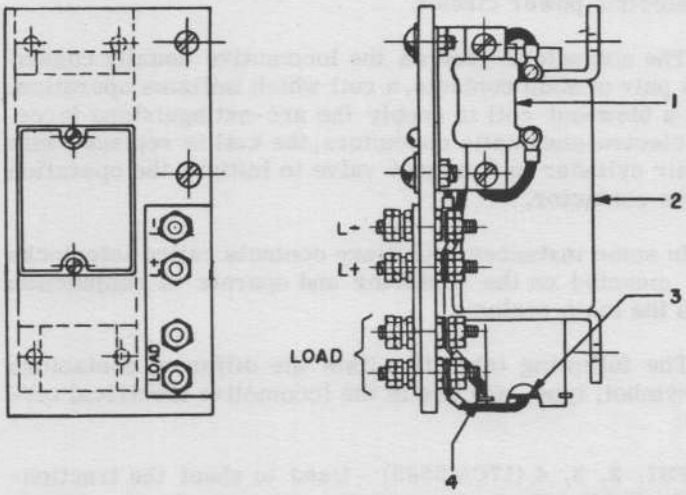


Fig. 3-8 (E-6082C)

1 Resistor
2 Coil
3 Plunger and contact assembly
4 Retaining clip

Fig. 3-8. Type 1200 Adlake relay

CONTROL EQUIPMENT

DATA

Coil Resistance at 25C (77F)	370 ohms
Resistor Resistance at 25C (77F)	300 ohms
Resistor	30 watts
Time Delay	5 seconds

Maintenance and Test
(See Fig. 3-8)

The coil (2), plunger and contact assembly (3), and resistor (1), are the major replaceable parts of the relay. Do not disassemble these components for the purpose of maintenance and repair.

Plunger and Contact Replacement
(See Fig. 3-8)

Replace the plunger and contact assembly when the time delay is erratic or out of range, or if the contacts fail to make proper contact.

1. To replace the plunger and contact assembly, remove the retaining clip (4) which holds the plunger inside the coil. Disconnect the contact leads attached to the terminals marked LOAD.

2. Press down on the top of the plunger (the plunger is accessible through the opening at the top of the coil) and force out the defective plunger and contact assembly.

Coil Replacement

Replace the coil when its resistance is plus or minus 10 percent of the value given in the DATA section. The

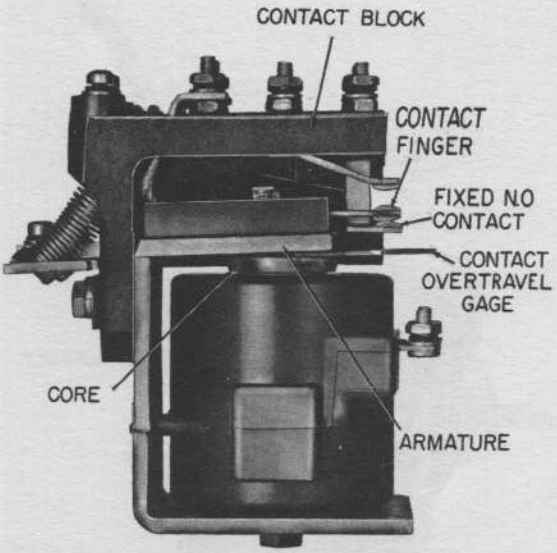


Fig. 3-5 (E-8320B)

Fig. 3-5. Setting normally open contacts with contact-overtravel gage

NOTE: *The 17LV68E2 ground relay is electrically and physically similar to the type 17LV66 relay except for the addition of the latching mechanism. The latching mechanism is preset at the factory and requires no further adjustment.*

DATA

COILS	17LV68E2	17LV66J10
Resistance at 25 C	73.0 ohms	453.0 ohms
Amperes to pick up	0.225-0.250	0.102 maximum

NORMALLY CLOSED CONTACT ADJUSTMENT (17LV66 AND LV68)

1. Install the overtravel gage as shown in Fig. 3-3.

2. Bend the normally closed contacts at right angles, using the contact adjuster, as shown in Fig. 3-4, until a 0.003-inch gap is obtained between all contacts. Use a 0.003-inch feeler gage for checking.

3. Remove the gages and operate the armature by hand; see that all contacts make at the same time.

NORMALLY OPEN CONTACT ADJUSTMENT (17LV66 AND LV68)

1. Install the overtravel gage as shown on Fig. 3-5.

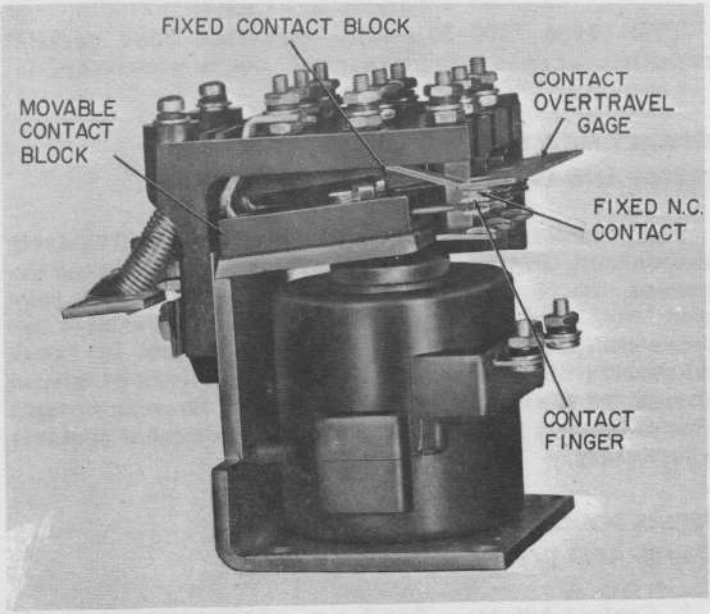


Fig. 3-3 (E-8319B)

Fig. 3-3. Setting normally closed contacts with contact-overtravel gage

CONTROL EQUIPMENT

RELAYS

INTRODUCTION

Relays are remotely controlled electro-magnetic devices for opening and closing electric control circuits. They operate in much the same manner as a magnetic contactor. They have an armature, a coil to pick up the armature magnetically, and contacts for completing control circuits.

Relays are used to establish circuits for proper sequence of operation of other devices, and to provide circuit protection against electric abnormalities.

The following tabulation lists the relays by symbol, type, and use in the locomotive electrical circuit:

BR1 (Type 17LV66J10) - Used to set up dynamic-braking circuits.

BR2 (Type 17LV66J10) - Used to set up the dynamic-braking circuits when the General Electric unit is trailing a unit of another manufacture.

CR1 (Type 17LV66J10) - Used to set up the automatic-transition and field-shunting circuits.

DVR (Type 17LV66J10) - Used for the sequence of the CV and DV engine-speed solenoid valves.

ER (Type 17LV66J10) - Used as the engine-run relay to energize the engine-speed solenoid valves.

GOLR (Type 17LV59N13) - Used to detect power faults which could cause alternator overloading and go to ground.

GR (Type 17LV67C2) - Used to protect the power and control circuits in the event of a ground or flashover in the motor or generator circuits. An electrical reset button at the operator's station is used to reset a tripped relay on any locomotive of the consist.

CONTROL EQUIPMENT

THROTTLE HANDLE

The throttle handle has in IDLE and 16 running positions or notches numbered 1/2, 1, 1-1/2, 2, 2-1/2, etc., up to 8. This handle controls engine speed, tractive effort, and dynamic braking.

REVERSE HANDLE

The Reverse handle has positions: FORWARD, OFF, and REVERSE. It is used to control the direction of locomotive movement.

SELECTOR HANDLE

The Selector handle has positions 4, 3, 2, 1, OFF and B. The positions 4, 3, 2, and 1 are for motoring; the B position is for dynamic braking.

INTERLOCKING BETWEEN HANDLES

1. The Reverse handle can be removed in the OFF position only. When the handle is removed, the Selector handle must be in OFF or 1, and the Throttle handle must be in IDLE only.

2. The Reverse handle cannot be moved unless the Selector handle is in OFF or 1, and the Throttle handle is in IDLE.

3. The Throttle handle cannot be moved from IDLE unless the Selector handle is in 1, 2, 3, 4, or B.

4. The Throttle handle cannot be moved from IDLE when the Selector handle is in OFF.

5. The Throttle handle can be moved when the Reverse handle is in any position.

CONTROL EQUIPMENT

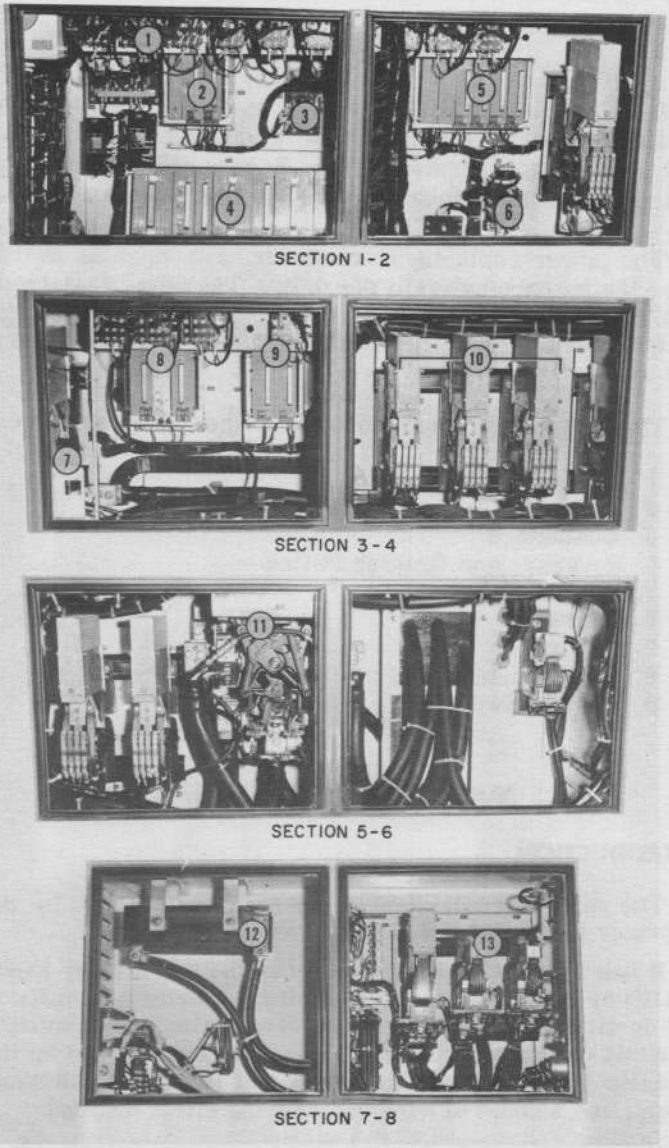


Fig. 3-1 (E-14697)

Fig. 3-1. Control compartment

CONTROL EQUIPMENT

A power card conducts the power to the generator field which controls the generator output. A regulator card continuously samples the generator's voltage and current output. Whenever the output varies from preset limits, the regulator card varies the operation of the power card to compensate and correct the generator output. For a detailed explanation of operation, refer to the CIRCUIT DESCRIPTION.

Circuit Description

The FH20 voltage regulator controls the voltage and current output of an auxiliary generator. The voltage regulator continuously samples the generator output and regulates this output by varying the generator shunt-field excitation.

The regulator (see Fig. 3-17) can be divided into the following five individual circuits:

1. Generator-field supply circuit.
2. Commutating circuit.
3. Gate-pulse circuit.
4. Voltage-regulation circuit.
5. Current-limit circuit.

During the explanation of operation, the reader should always keep in mind that the semiconductor operation being described occurs at any extremely fast rate. For example, the operation of SCR1 takes place in a matter of several milliseconds. This extremely fast rate of operation sometimes sounds rather slow when the circuit operation is being explained. Also, the operating values referred to should be considered as nominal (average values).

NOTE: *Be sure the diode is tightened into the heat sink at the proper torque value. If the diode is loose, the electrical connection will be poor; if the diode is too tight, the diode may be damaged internally.*

4. Wipe off any excess deposits of grease.

DATA TABLE

FORM	PANEL RATING IN AMPS	AMBIENT TEMP	HEAT SINKS	WEIGHT
B	95	100 C	2	5.5
C	277	85 C	2	16
D1	173	85 C	1	7
D2	118	85 C	1	7

FORM	NO. OF DIODES	CAPACITORS	REPLACEMENT TORQUE
B	2	1	50 in-lb
C	2	1	300 in-lb
D1	1	1	300 in-lb
D2	1	1	100 in-lb

CONTROL EQUIPMENT

REVERSE-CURRENT PANEL (17FM203)

Introduction

The FM203 panel is a reverse-current blocking device used to prevent a reverse flow of electrical current in a battery-charging circuit. Operation is as follows: When the generator is operating, its output often exceeds that of the battery and current flows from the generator, through the FM203 panel, to the battery. This is called the forward direction of current flow. When the generator is shut down, no current is flowing in the forward direction, and the output of the battery exceeds that of the generator. However, because of the blocking feature of the FM203 panel, current flow from the battery cannot reach the generator. Current flow from the battery toward the generator is called the reverse direction of current flow.

Components of the FM203 panel include heat sinks, silicon rectifiers, and capacitors. Each capacitor is used for transit voltage protection. Forms of the panel are shown in the following data table.

Maintenance

Visually inspect the panel at reasonable intervals, depending upon running time and conditions. Be sure that the power leads are tight, the wires are not loose or frayed, and the dirt has not accumulated. If necessary, blow any dirt out, using clean, dry, compressed air.

Trouble Shooting

The FM203 panel diodes (silicon rectifiers) can be tested for "open" or "shorted" conditions by measuring forward and reverse resistance with an ohmmeter. Do not disconnect leads from the panel while testing. Test the diode resistance as follows: See Fig. 3-15.

c. Repeat steps a and b for each event by placing the test meter across terminals R and S, and T and V.

NOTE: *To convert the frequency signal of either test set (17MM26 or 17MM28) to rpm, multiply the cycles by three.*

If there is input signal to the panel and each event operates correctly, the defect is not in the FL10 panel but in the circuit of the failed event. If no input signal is present, inspect the speed-sensing alternator for condition which would cause its rotor to fail to rotate.

After determining that the input signal to the panel is correct and that the trouble is in the panel, trouble shoot the cards by analyzing symptoms and replacing cards as follows:

1. If the indicated failure affects all events, the trouble is in the No. 207 card or in the components of the small auxiliary panel. First, replace the 207 card with a card known to be good. If the trouble is not eliminated, check the components of the auxiliary panel for the following:

a. Resistance of the filter choke (X). Resistance should be 6535 ohms plus or minus one percent when measured at 25 C (77 F).

b. Condition of the RD1 diode.

2. If the failure is confined to only one event, the trouble is in the No. 210 card that initiates that event. Correct by replacing the defective card with a card known to be good.

Contacts are provided in each event-circuit to short out a portion of P2 resistance. This recalibrates the point of dropout of SR relay to provide a differential between the pickup and dropout setting of each event.

Test Equipment Required

The following test equipment is required to maintain and test the transition equipment panel on the locomotive.

1. Simpson meter, Model 260 or equivalent

2. Type MM26 or MM28 (preferred) test set to supply an a-c signal.

Maintenance

The components of the panel and cards do not require scheduled maintenance or adjustment. Although most of the component parts are protected by a thin coating of plastic, the panel should still be kept free of dirt and moisture. All terminals (including solder connections) must be kept tight. If a failure occurs, the TROUBLE SHOOTING section of this publication should be consulted as an aid in locating the failed component or circuit.

CAUTION: *WHEN MAKING INSULATION TESTS ON THE CONTROL CIRCUITS OF THE LOCOMOTIVE, SHORT OUT TERMINAL CONNECTIONS ON THIS PANEL TO PROTECT THE SEMICONDUCTOR DEVICES FROM OVERVOLTAGE.*

DO NOT CHECK THE PANEL CIRCUITS OR COMPONENTS WITH A BELL SET. INDUCTIVE VOLTAGES CAN CAUSE FAILURE OF THE STATIC COMPONENTS.

CONTROL EQUIPMENT

AUTOMATIC TRANSITION EQUIPMENT PANEL (17FL10 AND 17FL11)

Introduction

The models 17FL10 and 17FL11 automatic transition equipment panels are locomotive static-control units which receive and convert speed signals into various operating events such as field shunting and overspeed warning. The FL10 panel is a three-event panel and the FL11 is a four-event panel.

The FL10 panel is composed of one small auxiliary panel, which is mounted on the frame of the main panel, and four plug-in cards. The auxiliary panel holds static components common to the four cards.

Three cards marked 210 are identical except for the setting of the two rheostats (P1 and P2 on Fig. 3-14) mounted on each card. These cards each control one event. The point of event initiation, with respect to the speed signal fed into the panel, is controlled by the rheostats.

NOTE: *Cards numbered 210 can be interchanged only if the rheostats are recalibrated.*

The fourth card (marked 207) houses a full-wave bridge-rectifier circuit for converting the a-c output signal of a speed-sensing alternator into filtered d-c. The 207 card has no adjustable parts and can therefore be interchanged or replaced without adjustment.

Operation of the panel is dependent upon a source of a-c voltage generated by a speed-sensing alternator. The generated a-c voltage is increased by a transformer (transformer may be part of another panel or a separately mounted device) and converted to d-c through a recrifier circuit consisting of a full-wave bridge (RT), a reactor (X), and a capacitor (C2). See Fig. 3-14.

Slip Without Correction

If a wheel slip or slide occurs without corrective action or indication, proceed as follows to check the circuits:

1. Using the MM37 or MM28 test set, put one axle signal into any axle circuit with the alternator wires removed from the panel. The wheel-slip relay external to the panel should pick up. If the relay picks up, the trouble is external to the panel. If the relay does not pick up, the trouble is within the panel or in an open relay coil.

2. Open Relay Coil

With the battery switch closed, connect a jumper from TBAA to the positive side of the wheel-slip relay (LV66) coil. The relay should operate. If the relay does not operate, replace the coil.

3. Open Wheel-slip Transistor

Remove the 182 card and, with a Simpson meter on the R X 10,000 scale, check for an open transistor by measuring between Pin K and Pin F. If the transistor is open (no resistance), repair or replace the card.

4. Open Sensitive-relay Coil

Remove the 183 card and, with a Simpson meter on the R X 100,000 scale, check the resistance of the coil between Pin J and Pin K. The resistance should be 10,000 ohms. If the coil is open, replace the relay.

5. If the coil and transistor are not defective, connect a voltmeter on the 250-volt scale across the contacts of the sensitive relay (TBY (+) and TBZ (-)). The voltage should be 60 to 70 volts when the test set is shut off. When the test-set output is increased, the voltage should drop to

b. If the resistance is within limits, check the alternators. Remove each alternator and inspect the axle drive. The rubber coupling assembly should be free of any cracks and should not have any radial movement before turning the rotor. The spade should fit in the axle with a minimum amount of radial clearance. If any of these defects are found, repair or replace the defective part or parts. On locomotives using "AP" bearings, make sure the large nut on the end of the bearing is tight.

If the MM28 test set is used to check the circuits when a continuous slip indication is noted with the locomotive moving, proceed as follows:

1. Disconnect all external leads from the alternators to the panel, at the panel terminal board (TB-A through TB-H).

2. Connect an MM28 test set so the leads are connected to the points on the panel terminal board where the alternator leads were removed.

3. Close the battery switch.

4. Gradually increase the MM28 test-set output to a maximum of 200 cycles (600 rpm). If an alarm sounds, the trouble is in the panel. Locate the defective card by replacing the cards one at a time in the following sequence: 183 card, 182 card, 181 card, 180 card, and the 144 card.

5. If an alarm is not given, the trouble is in the axle-alternator circuits. Check the alternator circuits as follows:

a. Measure the resistance of each alternator circuit by connecting a Simpson meter across leads A and B, D and C, F and E, and H and G. The resistance between each pair of leads should be 73 to 83 ohms.

Trouble should be located and repairs or replacement of the failed component should be made before the panel is adjusted. All cards are pre-set to a STANDARD at the factory; therefore, any ADJUSTMENT made would disrupt adjustments made at the factory. This also means that if the MM28 test set is used to check the card, that a card that has been set at the factory (STANDARD) must be used to adjust any repaired circuit or card. If the MM37 test set is used, the STANDARD card is not required.

Trouble Shooting Panel on Locomotive

Trouble shooting the panel on the locomotive can be done most effectively with the MM37 Adhesion-loss Detection test kit. By following the instructions in the test kit, the rotation of all four axle-alternators can be simulated and the panel can be tested to determine the trouble.

> **WARNING:** *REPLACE ALL CARDS REMOVED FROM THE PANEL AFTER EACH STEP OF TROUBLE SHOOTING IS PERFORMED; OTHERWISE, THE PANEL WILL NOT OPERATE.*

Symptoms covered in the following steps are those which are most likely to occur:

Continuous-slip Indication

1. If a slip indication occurs at some definite speed below which there is no actual slip, it is possible that an axle circuit is out of balance. Use the MM37 test kit to check and reset the balance of all the axle circuits. The balance potentiometers cannot accurately be set for the entire speed range by comparing resistance of the potentiometers.

Also, check the high-speed sensitivity circuit with the MM37 test kit and adjust the circuit if necessary.

2. Remove the wires to the transition panel, to be sure that some fault in the transition panel is not loading down

2. Diode RD22 and resistor R14 provide protection to the WST1 transistor against inductance caused by the SSR relay coil (17FC183A1 card only).

3. Starts the corrective action in the control circuit when signaled by any of the axle-alternator circuits.

Filter-reactor Card (144)

The components mounted on the Filtering-reactor Card "smooth out" the d-c voltage from the saturating transformers.

Terminal Points

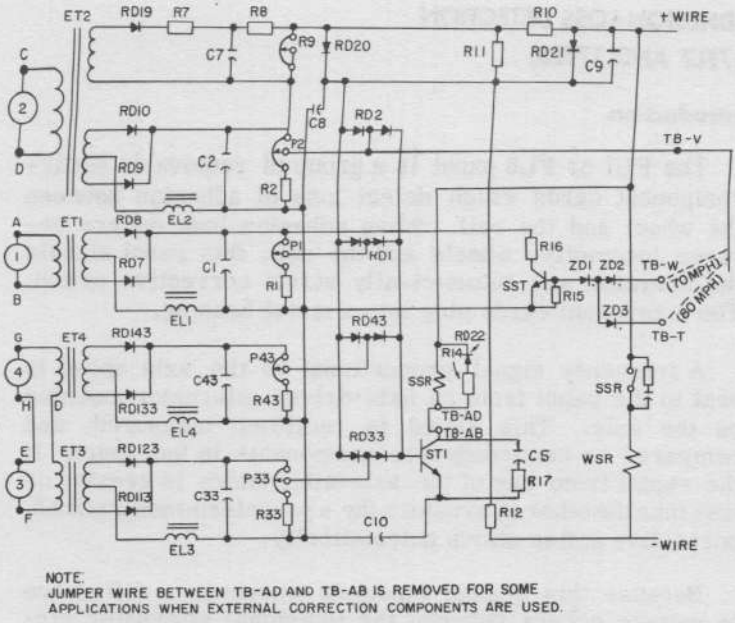
Plug-in bayonet points mounted on each card are lettered A, B, C, etc. These points make all connections between the cards and the contacts in the panel. External connections to the panel are made at the terminal studs at the base of the panel.

Maintenance

The components of this panel do not require scheduled maintenance or adjustment. Most of the components are protected by a thin coating of transparent plastic; however, the panels should be kept free of dirt and all terminal connections should be kept tight. In the event of a failure, the trouble-shooting section of this publication should be consulted to help locate the failed component or circuit.

CAUTION: *DO NOT CHECK THE CIRCUITS WITH A BELL SET. SHORT OUT ALL TERMINALS WHEN MAKING AN INSULATION TEST ON CONTROL CIRCUITS. THIS PROTECTS THE SEMICONDUCTOR DEVICES FROM HIGH VOLTAGE.*

CONTROL EQUIPMENT



NOTE:
JUMPER WIRE BETWEEN TB-AD AND TB-AB IS REMOVED FOR SOME APPLICATIONS WHEN EXTERNAL CORRECTION COMPONENTS ARE USED.

Fig. 3-13 (E-13325)

Fig. 3-13. Schematic diagram of 17FL7 adhesion-loss panel

2. They compare the output d-c voltages. The voltages are proportional to the speed of the axle-alternators that are connected to the card. This card is connected with the Axle and Synchronous-slip Card (181) and with the Axle and Sensing Card (182), so that the combined output of all the d-c voltages which are proportional to the axle-alternator speeds are compared in the same network.

Axle and Synchronous-slip Card (181)

Components mounted on the Axle and Synchronous-slip Card permit the following functions:

1. They measure axle-alternator frequency of one axle, and convert the frequency to an output d-c voltage.

CONTROL EQUIPMENT

TESTING

Testing of the alternator is unnecessary unless a malfunction in the system is evident. If a malfunction exists, refer to the publication covering the system to which the alternator is applied, such as wheel slip, transition, or speedometer.

STATIC PANELS

INTRODUCTION

The static panels used on the locomotive are a new concept in design. They contain no moving parts, and are made up of static components (diodes, transformers, transistors, resistors, and rheostats) mounted on cards which slide out of the panels for easy inspection, adjustment, and replacement. The static components measure and rectify a frequency signal furnished by an alternator or an oscillator. They also perform such functions as automatic transition, adhesion-loss control, and voltage regulation of the auxiliary generator.

A more detailed description of each panel function will be found in the particular panel instructions.

The panels that will be covered in the following instructions are:

1. Adhesion-loss Detection (Type 17FL7, FL8)
2. Automatic Transition (Type 17FL10, FL11)
3. Reverse Current (Type 17FM203)
4. Static Voltage Regulator (Type 17FH20)

CONTROL EQUIPMENT

ALTERNATOR (ALT)

INTRODUCTION

The 17MM24 alternator is a 40-pole, permanent-magnet, speed-sensitive generator used to supply an electrical signal to a detection panel that performs such functions as: detecting wheel slip, initiating transition, and measuring locomotive speed.

It consists of a stator, a rotor, and a permanently lubricated shaft-and-bearing assembly. The molded stator consists of 40 bar magnets, 40 steel laminations, and one random-wound coil. The molded rotor consists of 20 L-shaped (active) laminations, 20 shorting laminations, and a stainless-steel hub. The bearing-and-shaft assembly consists of a double-row bearing assembly, with the inner races ground into the shaft.

As the rotor turns, the laminations make and break magnetic circuits around the stator coil and induce a voltage in the coil. The magnets are arranged so that the poles are alternated. While 20 magnets of like polarity are working in parallel to induce voltages in the coil, the other 20 (of opposite polarity) magnets are shorted to prevent their leakage flux from reducing the output of the working magnets. This completes a half cycle. The frequency of the alternator is 20-cycles per revolution. For the next half-cycle, the previously shorted magnets become working magnets and the working magnets become shorted magnets, thus, completing the cycle. Refer to Fig. 3-12 for a view of the magnetic circuits. The voltage output of the alternator varies with axle speed, and is fed into a transformer, rectified, filtered, and fed into a load resistor. These components are all mounted in a panel. The resulting d-c signal is then available to detect wheel slip or wheel slide, initiate transition, and measure locomotive speed.

CONTROL EQUIPMENT

INTERLOCKS

INTRODUCTION

Interlocks are auxiliary, low-voltage contacts mounted on another device, such as a contactor, power switch, reverser, etc.

They are auxiliary contacts for opening and closing electric control circuits. They may either open or close when the device on which they are mounted operates.

Those contacts that are open when the device is de-energized are referred to as "Normally Open"; those that are closed are referred to as "Normally Closed".

These auxiliary contacts are usually small contacts connected in the control circuits. They are used to prevent improper operation of another device, to provide a signal that another device has or has not operated, to rearrange other circuits, and to prevent improper sequence of operations, etc.

INSPECTION AND MAINTENANCE

1. See that contact tips are not excessively pitted or badly burned. If the silver is worn through, or deeply pitted, replace the contacts.

2. Touch up with an ignition point file if only slightly pitted or corroded. Do not file out the small pits.

3. Resharpen any worn, serrated contact surfaces with a small, triangular, ignition point file.

4. Be careful not to bend the contacts when cleaning or filing.

5. Adjust type 17AF14 interlocks for correct tip break and overtravel by adding or removing shims under the

Fig. 3-17 (E-14684)

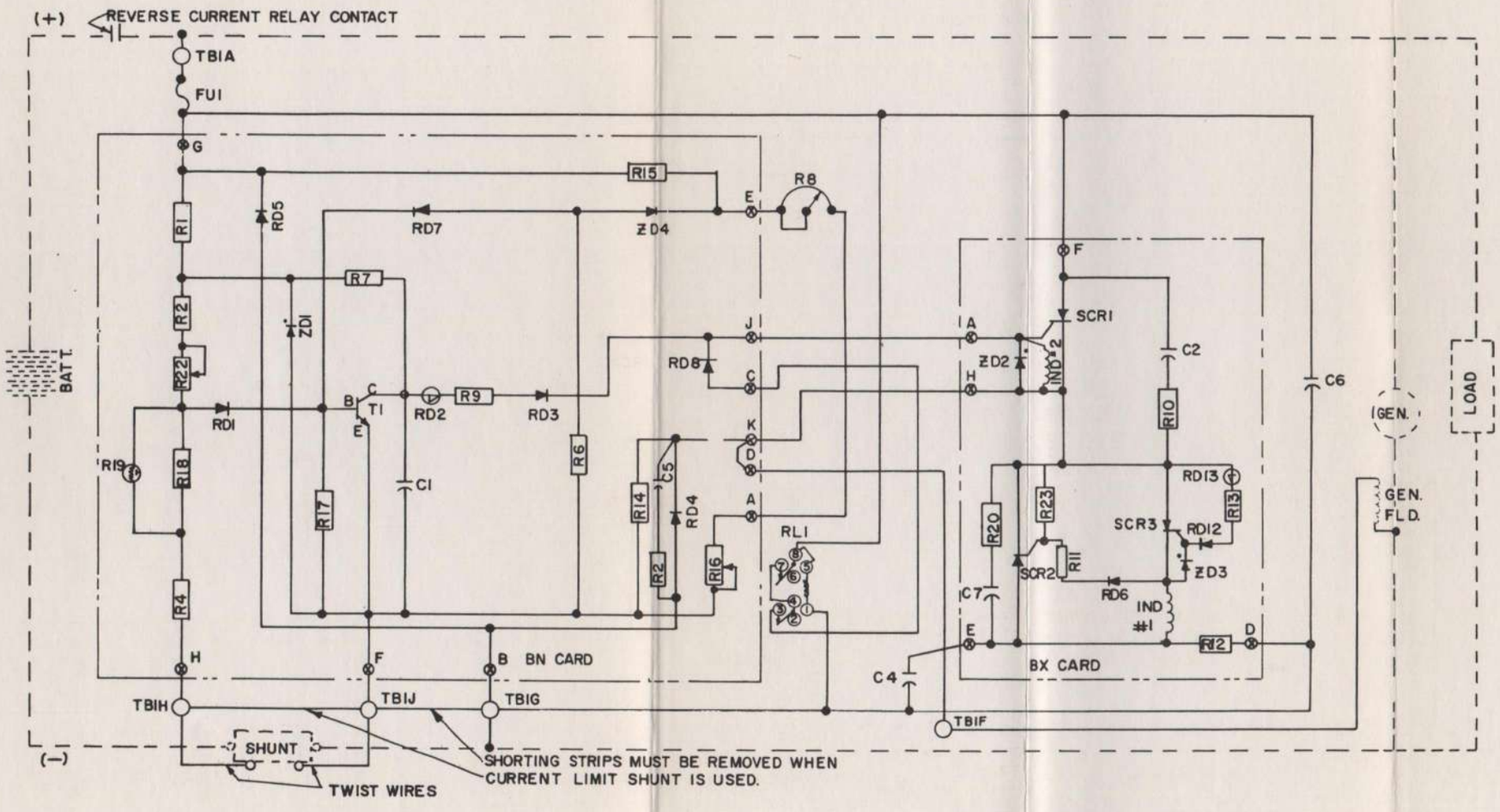
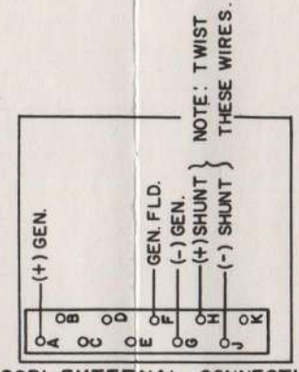
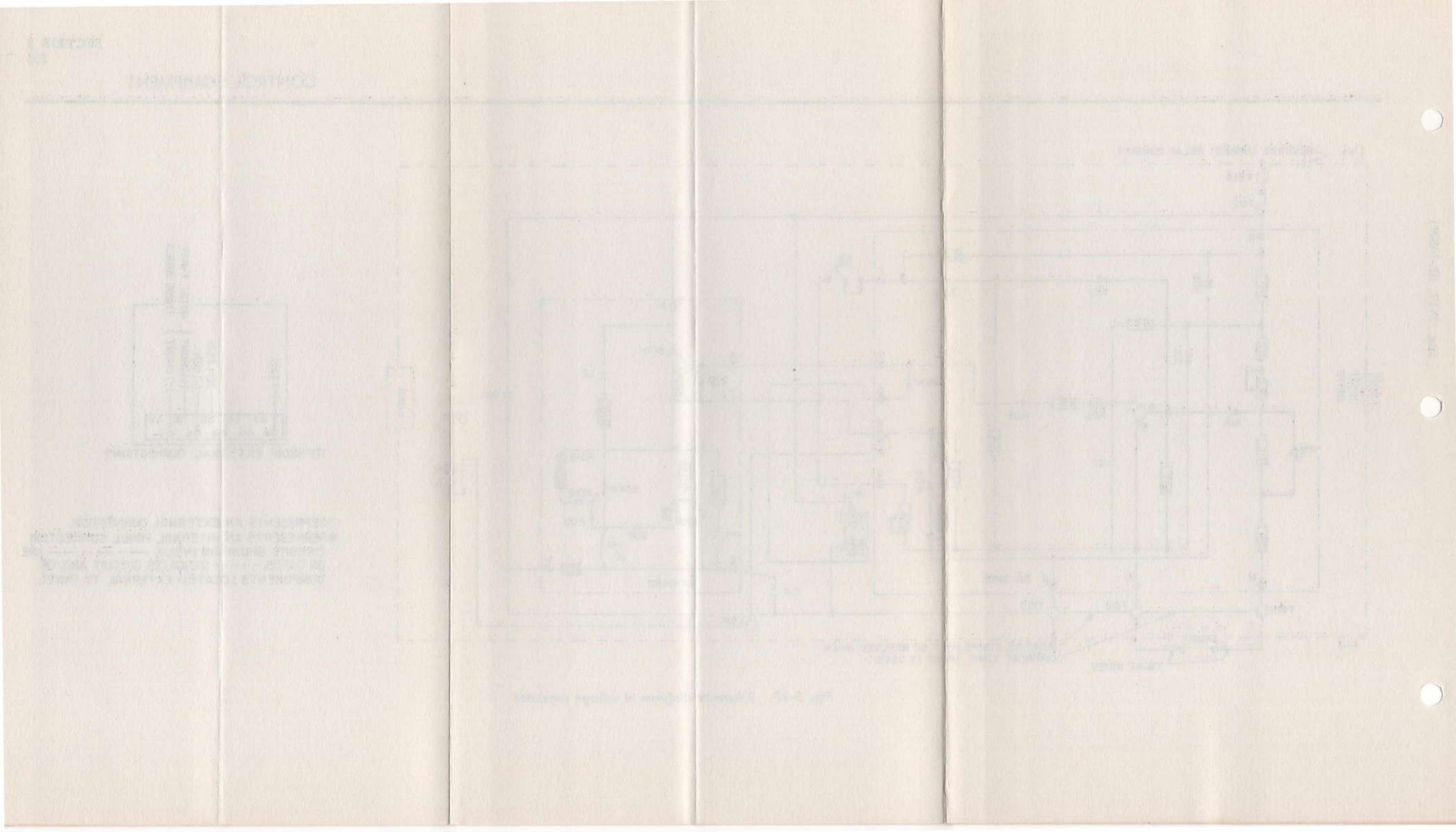


Fig. 3-17. Schematic diagram of voltage regulator



17FH20BI EXTERNAL CONNECTIONS

○ REPRESENTS AN EXTERNAL CONNECTION.
⊗ REPRESENTS AN INTERNAL PANEL CONNECTION
CIRCUITS SHOWN ON INSIDE —— — — ·· —— ARE
ON CARDS. - - - - - INDICATES CIRCUIT AND/OR
COMPONENTS LOCATED EXTERNAL TO PANEL.



CONTROL EQUIPMENT

NOTE: *This voltage regulator is designed to regulate at 75 volts d-c with a maximum current rating of 15 amperes (at 85 C) on the negative generator lead.*

Generator-field Supply

There are two paths for the generator field supply. The first path is used during the time when the generator voltage is building up from zero to 40 volts. During this time, the relay (RL1) is in its de-energized position. The generator field supply is then from TB1A through FU1, RL1 contacts, pin C (regulator card), RD8, Pin J (regulator card), pin A (power card), IND 2, pin H (power card), pin K (regulator card), pin D (regulator card), and TB1F to the generator field. During this time when the generator output is building up, the coil of RL1 is across the line and is seeing the same voltage as the generator field. As the generator output reaches 40 volts, RL1 is energized and removes the first generator-field supply path.

The second generator-field supply path is from TB1A through FU1, pin F (power card), SCR1, pin H (power card), pin K (regulator card), pin D (regulator card), TB1F, and across the generator field. As the generator output is building up, and before RL1 is energized, SCR1 is turned on. This provides two generator-field supply paths momentarily, and allows a smooth and uninterrupted transition between the first and second path.

Commutating Circuit

The commutating circuit turns SCR1 off, while the gate-pulse circuit turns SCR1 back on. The timing cycle or on-and-off time of SCR1 determines the amount of generator field excitation. This variable amount of field excitation will govern the output of the generator. Com-

mutation or turn-off of SCR1 will begin when the Shockley diode (RD13) begins to conduct. This occurs when approximately 40 volts is applied to RD13. Until voltage reaches this point, RD13 will not conduct. With 40 volts applied, RD13 will conduct and turn on SCR3 by energizing SCR3's gate through RD13, R13, and RD12.

At this point, the power passing through SCR1 has two ways to go. One path is through pin H (power card) to the generator field; the other is through SCR3. From SCR3, the power is conducted through inductor IND 1 to capacitor

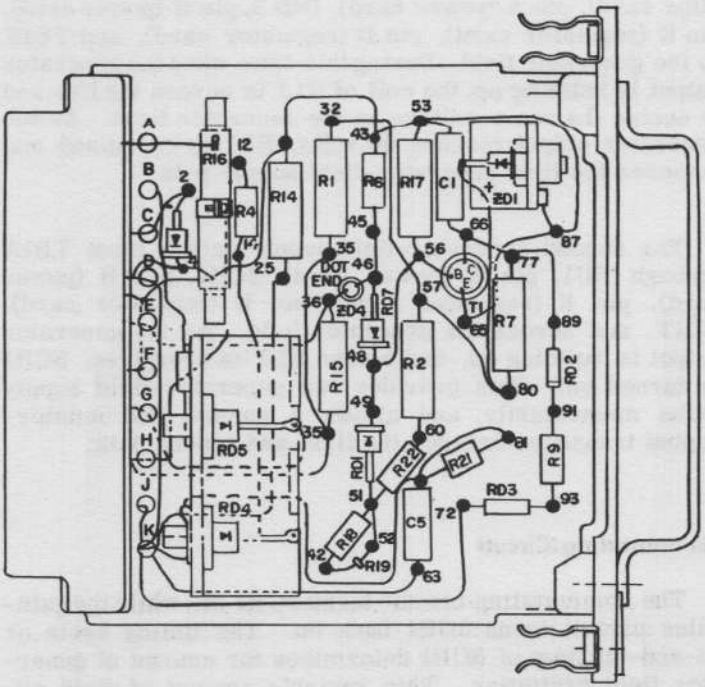


Fig. 3-18. Regulator card (BN) (typical)

Fig. 3-18 (E-10671A)

C4. IND 1, connected in series with C4, forms a series-resonance circuit. In this type of circuit, the capacitor will charge to approximately double or two times the voltage applied to the inductor.

When C4 is fully charged, the current flow through IND 1 will reverse and C4 will begin to discharge. As C4 begins to discharge through IND 1, SCR3 will be turned off, and SCR2 will be turned on when its gate is energized through IND 1, RD6, and R11. When SCR2 turns on, C4 will completely discharge through SCR2 and back-bias or turn off SCR1.

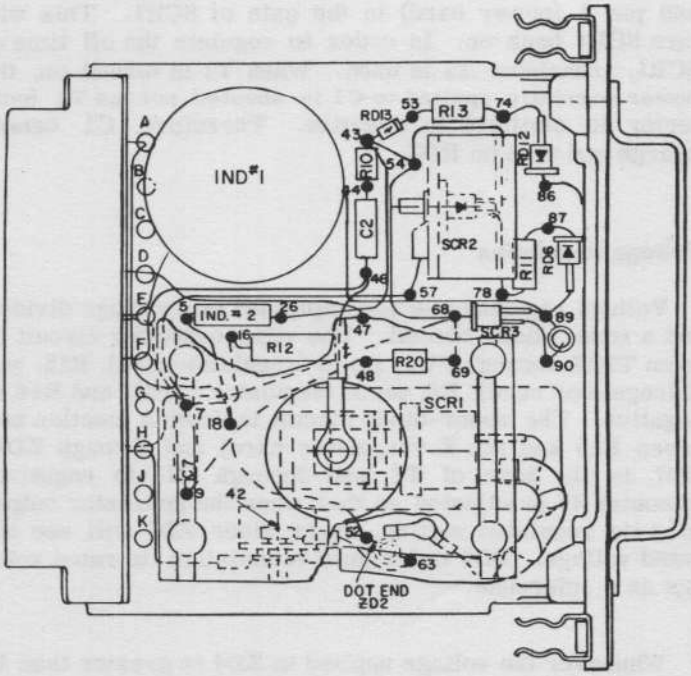


Fig. 3-19 (E-10672A)

Fig. 3-19. Power card (BX) (typical)

Gate-pulse Circuit

This circuit will turn SCR1 back on after the commutating circuit has turned it off. The circuit is from TB1A through FU1, pin G (regulator card), R1, and across ZD1 to negative.

ZD1 is a 27-volt zener diode that limits the voltage across R7 and C1 to no more than ZD1's rating. The circuit continues from ZD1, through R7, to capacitor C1. There is a junction between R7 and C1 that is connected to the collector of transistor T1 and to Shockley diode RD2. In operation, C1 charges from 20 to 24 volts which are required to turn on RD2. Because of ZD1, C1 cannot charge to more than 27 volts. When RD2 conducts, power is applied through RD2, R9, RD3, pin J (regulator card), and pin A (power card) to the gate of SCR1. This will turn SCR1 back on. In order to regulate the off time of SCR1, transistor T1 is used. When T1 is turned on, the power normally applied to C1 is shunted across T1 (collector to emitter) to negative. Therefore, C1 cannot charge and turn on RD2.

Voltage Regulation

Voltage regulation is accomplished by a voltage divider and a zener-diode circuit. The voltage-divider circuit is from TB1A through FU1, pin G (regulator card), R15, pin E (regulator card), R8, pin A (regulator card), and R16 to negative. The zener-diode circuit is from a junction between R15 and pin E (regulator card) and through ZD4, RD7, to the base of T1, and through R17 to negative. Rheostat R8 is adjusted so that when the generator output is at its regulated setting, zener diode ZD4 will see its rated voltage. ZD4 is designed to maintain its rated voltage as a reference.

Whenever the voltage applied to ZD4 is greater than 10 volts, it will conduct current to the base of T1. This will turn on transistor T1 and shunt the gate-pulse circuit.

Therefore, SCR1 will not turn on. This reduces the generator field excitation which, in turn, reduces the generator output. When the generator output drops back to its regulated setting, ZD4 will stop conducting, and T1 will turn off. The gate-pulse circuit will then continue functioning again.

Current Limit

The current demand on the generator is constantly sampled by this circuit which is controlled by the voltage drop across the shunt. This shunt is connected in series with the generator output.

The voltage drop across this shunt is proportional to the current it is conducting. The current-limit circuit has two paths connected in parallel with the generator output. The first path is from TB1A, through FU1, pin G (regulator card), R1, R2, R22, R18, and R19, R4, pin H (regulator card), TB1H, and across the shunt to negative. The second path is from a junction between R22 and R18, through RD1, across T1 (base to emitter), pin F (regulator card), TB1J, and the shunt to negative.

NOTE: *A thermister (R19) is a resistor whose resistance decreases with an increase in temperature. The common resistor increases in resistance with an increase in temperature. Thermister R19 is used in this circuit to compensate for temperature in the first path. This maintains a constant resistance in the first path throughout the temperature range in which this voltage regulator is designed to operate.*

During operation, when the current demand on the generator is below its preset maximum limit, the voltage drop across the first path will be less than the voltage drop

across the second path. Therefore, current will flow through the first path. However, when the current demand on the generator increases above its preset maximum limit, the voltage drop across the shunt will increase. This increased voltage drop across the shunt, when combined with the fixed drop across the first path, will be greater than the second path. At this time, current will flow through the second path and turn on transistor T1. When T1 turns on, the gate-pulse circuit will be shunted as described under VOLTAGE REGULATION. When the current demand on the generator drops back to its preset limit, the gate-pulse circuit will continue functioning again.

Maintenance

The panel components do not require scheduled maintenance or adjustment. Most components are protected by a thin coating of transparent plastic. Panels should be kept free of dirt and all connections should be tight. In event of failure, the trouble-shooting section should be consulted to help locate the failed component circuit.

CAUTION: *DO NOT CHECK CIRCUITS WITH A BELL SET. SHORT OUT ALL TERMINALS WHEN MAKING INSULATION TESTS ON CONTROL CIRCUITS. THIS PROCEDURE PROTECTS SEMICONDUCTOR DEVICES FROM HIGH VOLTAGE.*

Trouble Shooting

The trouble shooting of this regulator is divided into general test steps and correction and card steps and correction. General test steps and correction will normally be carried out on the locomotive, while card test steps and correction is intended for use on the bench. Only general test steps and correction will be described in this manual.

General Test Steps and Correction

The following test steps should be followed when checking or trouble shooting the regulator on the locomotive:

1. With the generator operating at idle speed, connect a voltmeter across TB1A (positive lead) and TB1G (negative lead). The meter should indicate 75 volts, ± 1 percent.

2. If the voltage output is high, proceed as follows:

NOTE: *Whenever high voltage is noted, open the battery switch and turn off any auxiliary loads which are subject to damage by overvoltage. Also, remove the fuse whenever high- or over-voltage is present. While trouble shooting the regulator during this condition, replace the fuse only when checking results upon completion of the test step. When checking is finished, remove the fuse again.*

a. Refer to ADJUSTMENTS and complete the voltage-regulation adjustment. If this does not correct the problem, continue with step 2b.

b. With the fuse removed, install a single-card extender behind the BN card. Connect a voltmeter (+) to pin C and (-) to TB1G; then, replace the fuse. If the meter indicates zero voltage, relay RL1 is operating correctly. However, if the reading is the same as the generator output, the contacts of RL1 have remained closed and the relay must be replaced.

c. After completing step 2b, check the generator output. If it is still high, remove the fuse, remove the BX card, and connect a multimeter (R x 10, 000 ohm scale) positive to pin E (BX card receptacle) and negative to TB1G. The meter needle should deflect toward zero ohms and then return to in-

finite resistance. However, if the needle deflects to zero ohms and stays there, or does not deflect at all, the capacitor C4 must be replaced (capacitor C6 may be checked in the same manner with the appropriate meter connections). If C4 tests good, then install a new BX card and check the generator output.

NOTE: *Whenever it is necessary to replace the regulating card (BN), refer to ADJUSTMENTS and adjust the voltage regulation and, if applicable, the current limit.*

3. If the voltage output is zero, proceed as follows:

   a. Remove and check fuse FU1. If faulty, replace it. Observe generator output.

   b. If generator output is still zero and the fuse is good, remove the fuse. Then pull the BN and BX cards. Connect a multimeter (R x 10,000 ohm scale) positive to pin G and negative to pin C (BN card receptacle). The meter will probably indicate infinite resistance because the contacts of relay RL1 will be open. If this is the case, the relay must be replaced. After replacing the relay, remove the multimeter and install the BN and BX cards. Replace the fuse and observe the generator output. If there are no unusual problems such as loose, shorted, or broken wires, loose connections, etc., the voltmeter could indicate any one of three readings:

   (1) 30 to 40 volts (pulsating): Refer to step 4 below.

   (2) 90 to 120 volts (steady): Refer to step 2 above.

   (3) 75 volts (steady): Regulator is operating properly.

c. If, after completing steps 3a and 3b, the generator output is still zero, the problem could be the loss of residual field excitation. In order to correct this situation, disconnect the positive generator field lead at TB1F and momentarily apply battery power (+ positive) to this lead. Reconnect this lead and retest.

4. If the voltage output is low, proceed as follows:

a. Refer to ADJUSTMENTS and complete the voltage regulation adjustment. If this does not correct the problem, continue with step 4b.

b. After completing step 3b, and if the meter reading is 30 to 40 volts (pulsating), connect a voltmeter (+) between RD2 and R9 and (-) to TB1G. Read 0.25 to 15 volts. If voltage is not in this range, replace the BN card. If the reading is within this range, check capacitors C4 and C6 as described in step 2c. If the capacitors are faulty, replace them and retest. If they are good, replace the BX card.

c. If the voltage is low (30 to 75 volts), and steps 4a and 4b have not corrected the problem, connect a voltmeter (+) to TB1H and (-) to TB1J. If a reading of 0.5 volts or higher is observed, the regulator is in current limit because an excessive load is being placed on the generator.

Adjustments

The following procedures outline a suggested method of adjusting the voltage regulation and current limit of the regulator. These adjustments are itemized for completion on the locomotive or on the bench.

NOTE: *Whenever removing a card from this regulator, first remove the fuse located on the front panel of the regulator.*

Voltage Regulation

On the Locomotive

1. Operate the generator at idle speed and open the battery switch (only for systems that use current limit). For all other systems that do not use current limit, close battery switch.

2. Connect a voltmeter (+) to terminal TB1A and (-) to terminal TB1G. Observe the generator voltage output (70 to 80 volts).

3. Adjust the rheostat VR for 75 volts output (observe the meter). If adjustment cannot be made with VR, remove the fuse. Take the BN card out of the panel and adjust the resistor R16.

NOTE: *The head of the slider-locking screw has been soldered. This is to prevent excessive or incorrect handling of the slider that could break some of the fine resistor wires. This resistor should only be adjusted when the required setting cannot be made with the VR rheostat. After R16 has been satisfactorily adjusted, resolder the screw head.*

4. Before adjusting R16, connect a multimeter (R x 100 ohm scale) positive to pin A and negative to pin F. Observe reading. Adjust R16 while observing the multimeter (15 ohms = approximately 1 volt change). An increase in the resistance of R16 will increase the generator voltage output. Replace the BN card in the regulator, install the fuse, and complete the adjustment with the VR rheostat.

CONTROL SWITCHES

INTRODUCTION

Three distinct types of control switches are required for locomotive circuit control functions. Each type is designed to safeguard locomotive devices from out-of-range temperatures or pressures. Also, each is designed to allow manual circuit selection by operating personnel.

The following control switches are found on the locomotive.

1. Temperature-control Switch
2. Pressure Switch

TEMPERATURE-CONTROL SWITCH (ETS)

Introduction

The engine-temperature switch (ETS) sounds an alarm and lights a red, hot-engine light on the engine control panel when the diesel-engine temperature exceeds 208 F (90 C). It is a bellows-operated device triggered by expanding liquid in a bulb set into the flow-control valve.

The switch incorporates a seamless metallic bellows that operates a snap-action switch. A built-in permanent magnet aids in quickly extinguishing the electric arc produced when the snap-action switch contacts open under load.

Setting Switch (See Fig. 3-20)

1. Turn the differential screw counterclockwise against the stop for minimum differential setting.

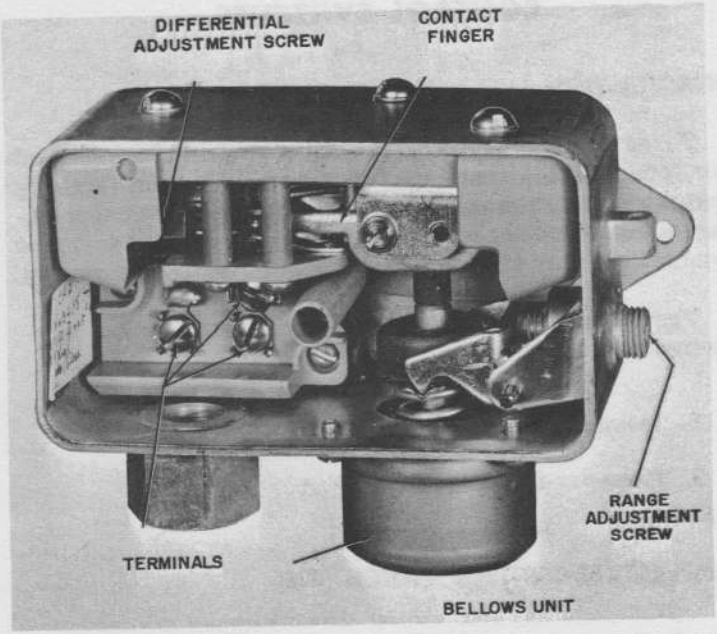


Fig. 3-20 (E-8267)

Fig. 3-20. Temperature-control switch

2. Bring the temperature point to where the snap switch is designed to operate (208 F)

3. If the contacts are open, slowly turn the range screw counterclockwise until the contacts just close.

4. If contacts are already closed, turn the range screw clockwise until the contacts open. Then, slowly turn the screw counterclockwise until the contacts just close. This adjustment fixes the closing point of the switch.

NOTE: *All references to "contacts open" or "contacts close" refer to the upper or the "B" contacts only.*

5. After setting the contacts to close at the desired temperature, the differential screw can be set to open the contacts at the desired temperature (201 F).

PRESSURE SWITCH (PCS AND WSS)

Introduction

The pressure switch has a steel case that houses a spring-loaded bellows and a snap-action switch. Rising and falling air pressure causes the contacts to make and break.

When no pressure is applied to the bellows, the switch terminals marked A provide a normally open circuit, while the terminals marked B provide a normally closed circuit. The B contacts remain closed until a maximum pre-determined air pressure is reached. At this pressure, the A contacts also reset. Then, the B contacts open and remain open, and the A contacts close and remain closed until the air pressure drops to a predetermined set value.

PCS - Power-Control Switch opens when pressurized and de-energizes the PCR relay, which returns the engine to IDLE and prevents movement of the locomotive until the air brakes are released and pressure in PCS has reduced to 44 psig.

WSS - Wheel-slip Pressure Switch closes when the air pressure in the automatic-sanding air reservoir has increased to a predetermined value, operating the WS light which warns the operator that wheel-slip sanding has taken place.

Maintenance and Setting (See Fig. 3-21)

The basic contact snap-mechanism contained in the switch must be replaced as a unit. This is done by taking

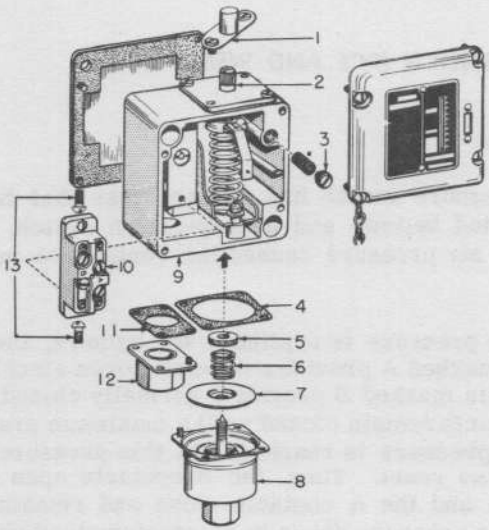


Fig. 3-21 (E-5675A)

1 Adjusting screw guard
2 Adjusting screw
3 Differential adjusting screw
4 Bellows gasket
5 Calibrating nut
6 Calibrating spring
7 Calibrating spring seal
8 Bellows assembly
9 Mechanism assembly
10 Snap switch
11 Conduit gasket
12 Conduit boss
13 Switch mounting screws

Fig. 3-21. Exploded view of pressure switch

out one screw (13), Fig. 3-21, from each end of the switch. Replace the switch with the same style snap mechanism that was removed.

Range adjustment - Adjustment of the operating point is made with the screwdriver adjusting screw (2). The range scale, shown on the cover of the assembly, refers to the operating point on falling pressure.

Differential adjustment - The differential-adjusting screw (3) is accessible by removing the cover and inserting a screwdriver in the large hole at the top right corner. Turning the screw clockwise increases the differential.

SB-TYPE SWITCH

Introduction

The SB-type switch is a hand-operated gang-type switch used for minor circuit control. It has an operating handle which is used to select the switching position for which it was designed.

RECTIFIER PANEL

INTRODUCTION

This basic information covers the model 17FM210D1 rectifier panel.

The form D1 panel is used to make a bridge-connected power rectifier which converts alternating current to direct current to drive traction motors. The principal parts of the panel include high-current silicon rectifiers, heat sinks, resistors, capacitors, and fuses.

CONTROL EQUIPMENT

SPECIAL TOOLS AND EQUIPMENT

1. Socket wrench (Cat. No. 41B551237G1)
2. Penetrox-A* compound (Cat. No. 1X7071)
3. Simpson analyzer or equivalent.

INSPECTION AND MAINTENANCE

Every 30 days, the panel should be checked for blown fuses. Any fuse, but only one fuse per row, can be blown and locomotive can be operated in revenue service to nearest repair shop. If two or more fuses are blown in any row, the locomotive should immediately be taken out of service. (See Fig. 3-22.)

NOTE: *Lifting holes are provided to assist in lifting panel. Use 3/8-16 screw eyes.*

*Burndy Corp.

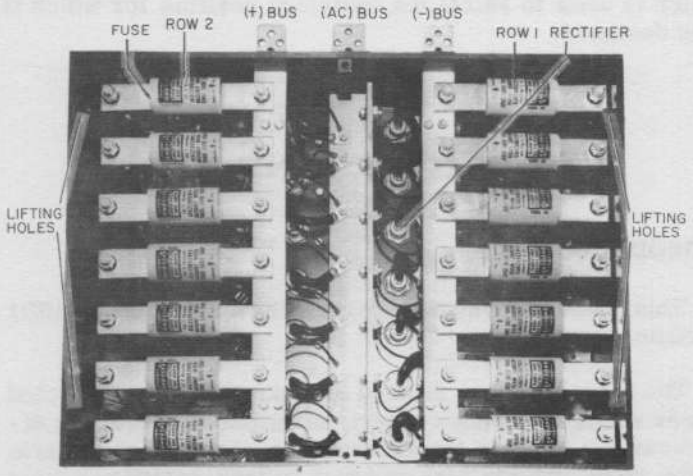


Fig. 3-22 (E-12983)

Fig. 3-22. Panel fuses

CONTROL EQUIPMENT

Every year, inspect the front of the panel for dirt accumulation and, if necessary, blow out with dry, compressed air. At this time, perform the component-resistance check indicated under trouble shooting and replace components as required.

Every five years, disconnect all panel connections, remove the mounting bolts, and inspect the rear of the panel for dirt accumulation. Blow out with dry, compressed air and scrape out dirt accumulations if necessary.

Fuse

Check for a blown fuse as follows:

1. Remove power to panel and blow out dirt accumulations with dry, compressed air.

2. Check all fuses by observing if the indicator pin protrudes 1/8 inch from the end of the body (see Fig. 3-23). Stencilled on the panel cover are arrows indicating through which holes the blown fuse indicator can be seen.

NOTE: *In Fig. 3-23, fuses have been removed for illustration purposes. Should the pin protrude as shown, the fuses are blown. If fuses are satisfactory, the indicator pin will be flush with the end of the fuse body.*

Remove the blown fuse as follows:

1. With power to panel removed. remove the panel cover.

2. Remove the blown fuse.

Replace the fuse as follows:

1. Inspect the new fuse to locate the indicator pin.

Fig. 3-23 (E-12985)

Fig. 3-23. Panel fuses shown in blown condition

NOTE: *On a fuse with a large body (old type), the indicator pin is located on the end which reads "Mount with this Side Up."*

On a fuse with a small body, (new type), the indicator pin is located by an arrow.

2. Position the fuse on the panel studs so that the indicator faces the center of the panel.

3. Assemble the nuts, washers, and lockwashers to the studs holding the fuse.

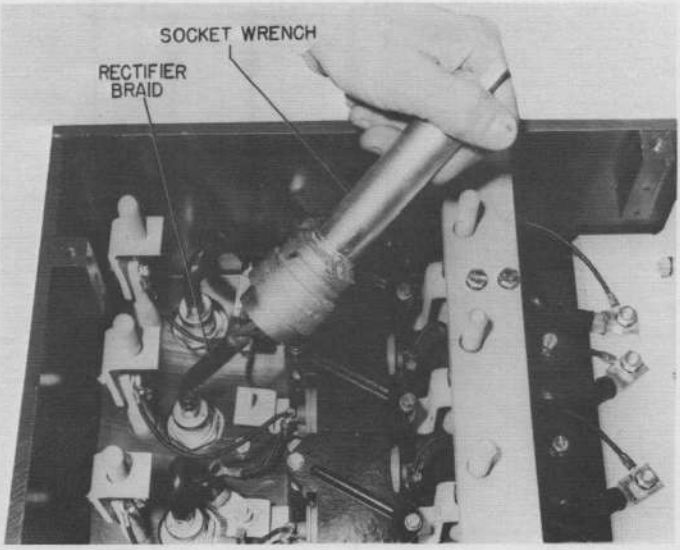


Fig. 3-24 (E-12988)

Fig. 3-24. Removal and replacement of rectifier

4. Trouble shoot the panel for the cause of fuse failure and replace components as necessary before returning the locomotive to service. See Trouble Shooting in back shop manual.

Rectifier

Remove the rectifier as follows:

1. After the fuse is removed, disconnect the rectifier braid (anode).

2. Remove the rectifier by inserting the braid upward into the socket wrench, by positioning the wrench over the hex part of the rectifier, and by loosening the rectifier (see Fig. 3-24).

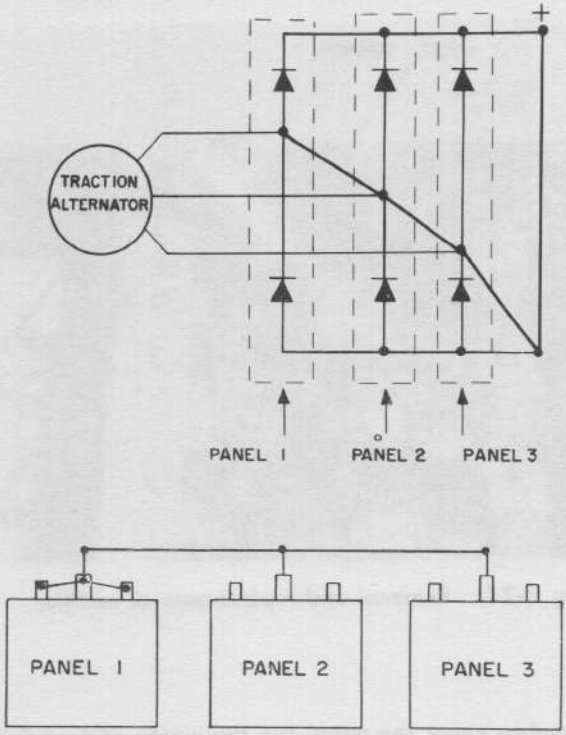


Fig. 3-25 (E-12990)

Fig. 3-25. Protective panel wiring before high-potential testing

Replace rectifier as follows:

1. Apply Penetrox-A compound to the rectifier threads and heat-sink seat.

2. Replace the rectifier in the reverse order of removal, making certain that the capacitor connection is also made.

CAUTION: *APPLY MAXIMUM TORQUE OF 25 FT-LB TO ALL RECTIFIERS TO OBTAIN PROPER ELECTRICAL CONTACT AND HEAT TRANSFER.*

CONTROL EQUIPMENT

CAUTION: *RECTIFIERS ARE NOT INTERCHANGEABLE BETWEEN DIFFERENT MODELS OF THIS PANEL. REFER TO TROUBLE SHOOTING SECTION OF RESPECTIVE MODEL FOR VOLTAGE RATING OF RECTIFIER BEFORE REPLACEMENT.*

CAUTION: *WHEN REPLACING THE RECTIFIER, CARE SHOULD BE TAKEN WHEN LOCATING THE RECTIFIER BRAID (ANODE) SO IT DOES NOT SHORT AGAINST HARDWARE OR BUS BARS.*

Capacitor

Remove the capacitor as follows:

1. Remove the power to panel.

2. Remove the fuse.

3. Remove the capacitor wire connected to the upright post.

4. Remove the capacitor wire connected to the rectifier braid and the ribbon resistor.

5. Remove the two No. 10-32 screws from the upper clamp.

6. Remove the upper clamp.

7. Remove the capacitor.

Replace the capacitor in the reverse order of removal.

Ribbon Resistor

Remove the ribbon resistor as follows:

1. Remove the power to the panel.

2. Remove the fuse.

3. Remove the clamp block assembly containing the capacitors.

4. Remove the end of the ribbon resistor connected to the heat sink.

5. Remove the other end of the ribbon resistor connected to the braided rectifier lead.

Replace the ribbon resistor in the reverse order of removal.

High-potential Protection

Before high-potential testing locomotive, connect the FM210 panels as follows to protect rectifiers:

1. Connect the three bus bars together on one panel.

2. Connect the a-c bus bars of all three panels together (see Fig. 3-25).

ROTATING EQUIPMENT

INTRODUCTION

The electrical rotating equipment of the locomotive fits two categories of apparatus, propulsion and auxiliary. The propulsion equipment (traction power) consists of the traction generator, traction motors and exciter. The auxiliary equipment consists of such devices as the auxiliary generator, equipment blower, and radiator fan.

Even though the rotating equipment is designed to require little maintenance, periodic inspection and cleaning of the equipment is important. Trouble that is located quickly can often be corrected before the equipment is beyond repair or before it becomes serious enough to cause an untimely breakdown.

The rotating equipment consists of the following components. Each device requires maintenance inspection at intervals. These intervals must be determined by rail conditions, hours running time, and work use to which the locomotive has been subjected.

1. Traction Alternator (TA) GTA-9
2. Exciter Generator (EXC) GY-29
3. Auxiliary Generator (A) GY-27
4. Traction Motor GE-752
5. Fan and Gear Unit GA-57

GENERAL MAINTENANCE

CLEANING

Determine a schedule for cleaning the rotating apparatus, based on operating conditions.

1. Clean dirt from openings, inspection covers, axle-cap covers, armature bearing caps, lubricant filler caps, and fittings.

2. Remove the commutator covers and blow out interior of apparatus with dry compressed air; maximum

pressure must not exceed 70 psi. Remove dirt, oil, or grease accumulations on accessible parts inside the frame of electric rotating equipment.

3. Clean "Teflon"** insulators on brush-holder supports. Do not sand or finish these insulators with paint or varnish. Wipe dirt from insulators with a clean dry cloth.

4. Clean the commutator string band and cable connections.

5. Look for defects in mechanical and electrical parts while cleaning. Check the varnished surfaces of the armatures and field coils for cracks or flaking.

INSPECTION

Make periodic and systematic inspections of the rotating equipment. Time intervals between inspection periods must be determined by operating conditions.

1. See that all mounting bolts are tight and that all electrical connections are secure.

2. Check the brush length in electric rotating equipment and be certain that sufficient length remains for operation until the next inspection period. See that the brushes move freely in the brush holders. Be sure that the brush-pigtail attaching screws are tight.

3. Check the commutators for roughness caused by burning, high bars, or grooving. Correct any commutator roughness before the fault increases beyond easy repair. See COMMUTATOR MAINTENANCE.

4. Listen for noisy bearings, preferably by using a listening rod.

**Reg. Trade-mark of E.I. DuPont de Nemours Co.

COMMUTATOR MAINTENANCE

The commutator is the copper reversing switch that controls the polarity of current flow FROM d-c generators TO d-c motor armatures. The commutator is mounted on the armature shaft and rotates with the shaft.

The commutator is made up of alternate copper segments and mica sections called side mica. The side mica separates the segments (bars) electrically and is undercut below the brush-riding surface of the bars. The bars are wedgeshaped so that when assembled, they form a cylinder. They are clamped between a steel shell and cap with bolts to obtain the required clamping action. Sheet mica is placed between the cap and shell, and the bars to prevent the bars from grounding. A string band is applied over the commutator cone to protect the mica. Each bar has a riser to form the connection with the armature coils. See Fig. 4-1.

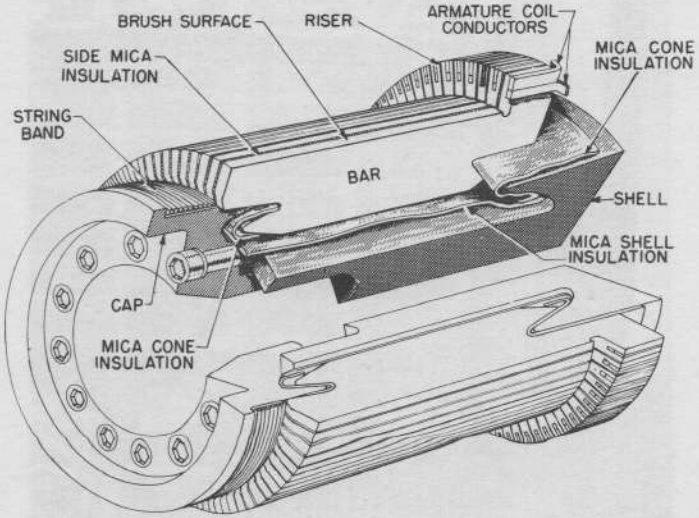


Fig. 4-1 (E-5018)

Fig. 4-1. Cutaway section of commutator

COMMUTATOR COLOR PATTERN

The term "color pattern" indicates that the color of the commutator bars is not uniform and a definite pattern exists. This pattern is almost always related to coil positions in slots, that is, to the number of conductors per slot. In itself, this condition is not a sign of damage. The color pattern may show up in several sequences as shown in Figs. 4-2 and 4-3. As long as there is a definite pattern all the way around the commutator, there is no cause for concern.

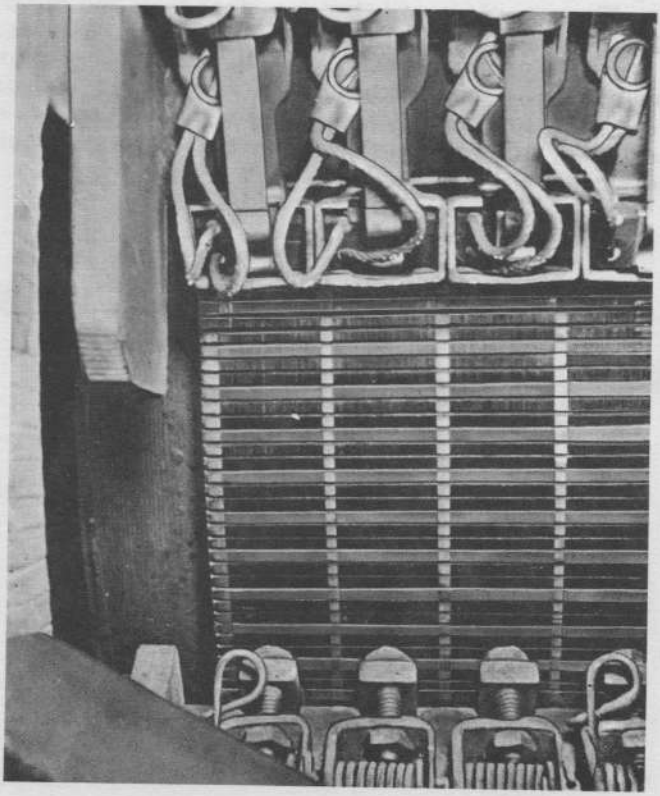


Fig. 4-2 (E-8762A)

Fig. 4-2. One light—two dark, 3 coil per slot color pattern

A check for surface damage should be made at regular commutator inspection periods. If no surface damage exists, no further action is required.

MARKING, ETCHING, AND FLAT SPOTS

General

The following conditions are indicated by discoloration and/or etching of the commutator bars to varying degrees.

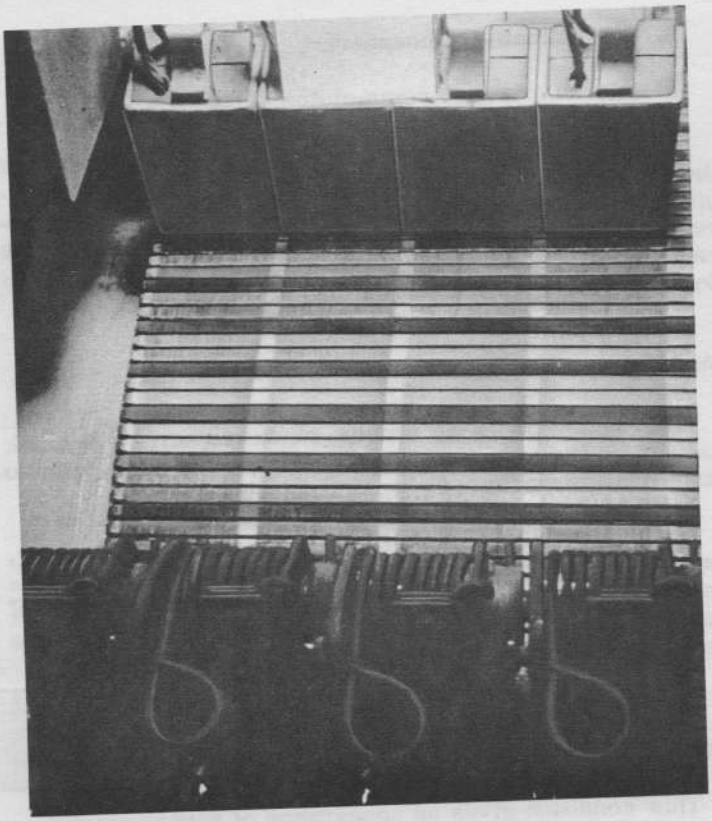


Fig. 4-3 (E-8763)

Fig. 4-3. One dark—two light, 3 coil per slot pattern

Some of the possible causes are:

1. Excessive loads on the machine

2. Electrical adjustment off, such as wrong shims behind commutating poles, or wrong interpole gap

3. Incorrect brush grade

4. Incorrect brush spacing

5. Incorrect brush shift

6. Contaminated atmosphere

7. Uneven or rough commutator surface.

The best remedy for these conditions is to determine the cause and make the necessary corrections. If commutator damage has not progressed too far, it may correct itself once the cause has been eliminated. If some resurfacing of the commutator is necessary, it must be done sparingly.

Marking

This condition is an opaque, darkened surface or black deposit on the bars, usually at their trailing edge, with no etching or corrosion of copper underneath.

To check the condition of the bars beneath the marking, use a common pencil eraser and rub away the film. Examine the copper surface for roughness or pitting. If none is seen, the condition is marking only, and can be removed with a canvas cloth. See Fig. 4-4.

Etching, Bar Surface

This condition gives an appearance of severe marking. A pencil eraser uncovers pitted, eroded or burned bar

Fig. 4-4 (E-8764)

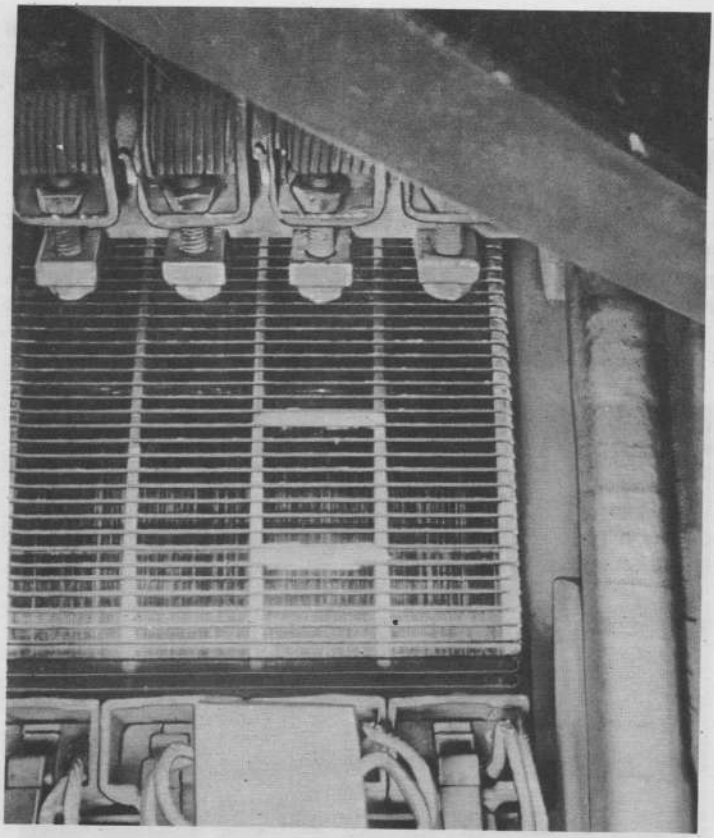


Fig. 4-4. Commutator film which can be removed with a pencil eraser, showing smooth copper surface underneath

surfaces. It results from arcing between the brush and the copper segments and is usually visible to the eye after the marking has been removed.

Etching, Bar Corners

This condition reveals that corners of the bars have been eroded, leaving a chamfered corner. There will

likely be no other evidence of marking or bar surface etching. See Fig. 4-5.

Flat Spots

If etching is not corrected and progresses too far, flat spots will develop. This condition can also result from mechanical causes, such as pounding from a loose bearing. However, as a rule, flat spots result from failure to

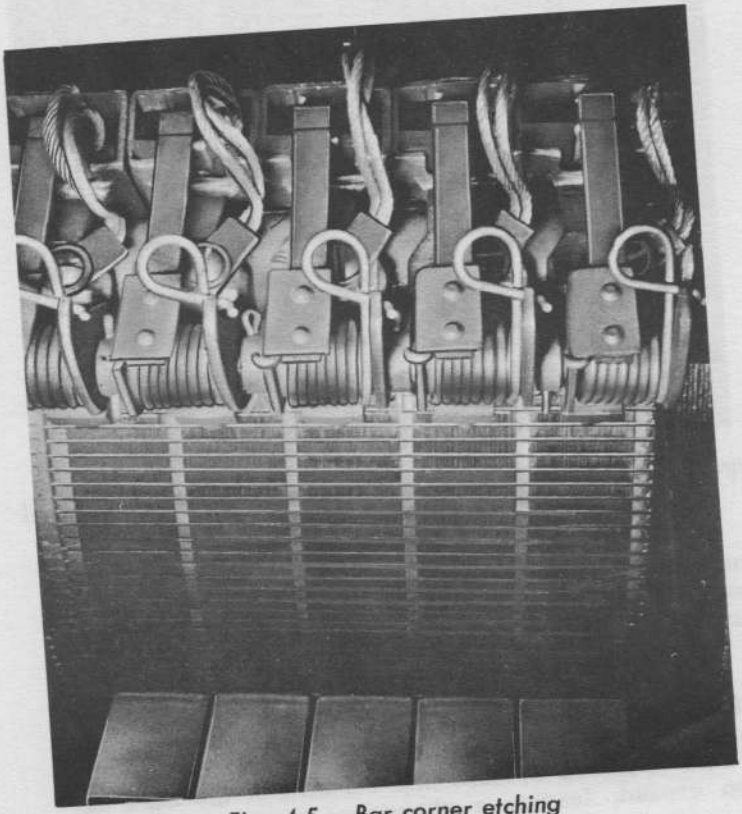


Fig. 4-5 (E-8765A)

Fig. 4-5. Bar corner etching

correct some faulty condition which was first indicated by burned bars. See Fig. 4-6.

THREADING

Threading is a surface defect running around the commutator at right angle to the bars. It shows up as narrow, circumferential lines or grooves cut into the commutator surface. Threading is usually caused by abrasive cutting between brush and commutator.

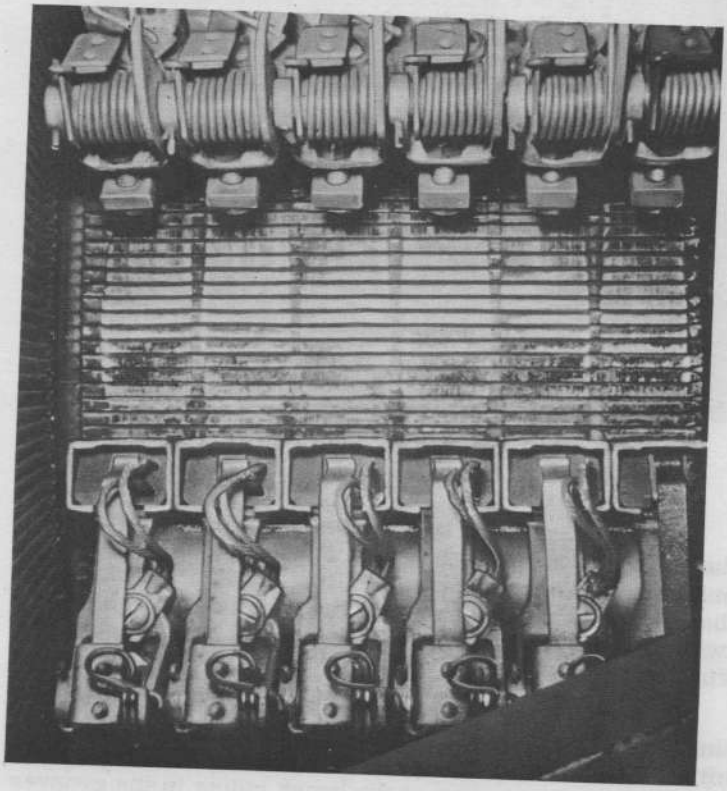


Fig. 4-6 (E-8767)

Fig. 4-6. Flat spots on commutator

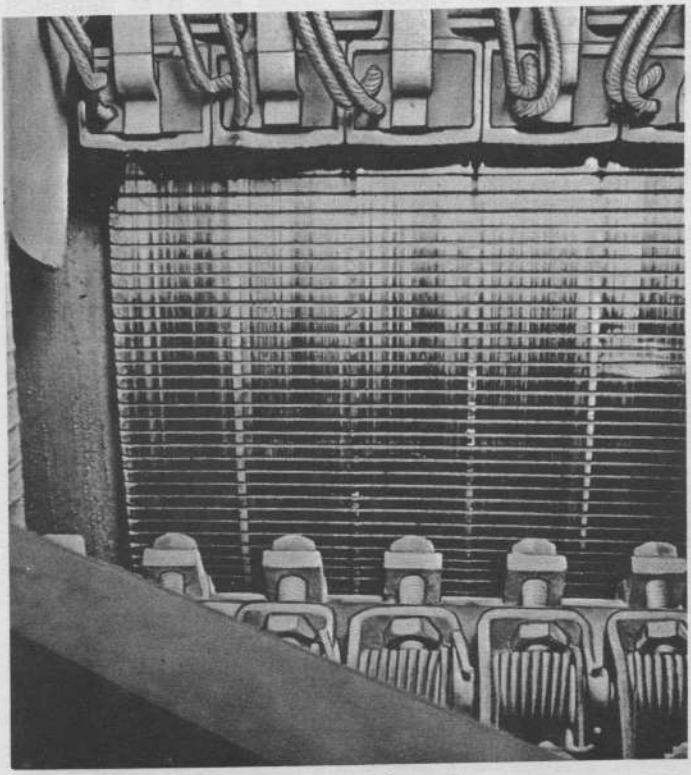


Fig. 4-7 (E-8768A)

Fig. 4-7. Heavy threading of commutator

In light threading, these lines may be located where the film or color is different than the rest of the commutator. In heavy threading, a fingernail scraped across the commutator will catch in the rippled surface. This type of threading is generally visible to the eye. See Fig. 4-7.

The brush face wears to fit threaded grooves. When the commutator shifts because of end play, the brush is either lifted out of the grooves resulting in sparking and burning, or the portion of the brush riding in the grooves breaks off. Either condition will result in poor operation

and probably will cause eventual failure of the brushes and/or the commutator. See Fig. 4-8.

The probable causes of threading are as follows:

1. Low brush-current density (when the machine runs for extended periods with very light loads)

2. Abrasive dirt or other foreign material imbedded in the bottom of the brush

3. Mica flakes or copper imbedded in the brush face

4. Wrong grade of brush

Correct threading by replacing the faulty brushes and by hand stoning, grinding, or turning the commutator as required, taking into consideration the depth of the threading.

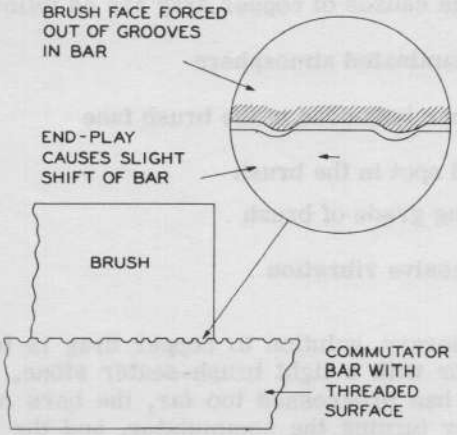


Fig. 4-8 (E-5023)

Fig. 4-8. Cutaway view showing threading of commutator surface

COPPER DRAG

Under certain conditions, copper is pulled over the edge of the commutator bars. This condition is known as copper drag and shows up as small flakes or feathers of metal that appear mainly on the trailing edge of the bars. The bar surface may also have an appearance which suggests that the copper has flowed or been peened toward the trailing edge. This condition is called copper drag or feathering and should not be confused with bar corner etching.

What actually takes place when copper drag appears is that the metal, which is normally transferred, is rubbed back onto the commutator as a layer of copper, copper oxide, and contaminants, and does not bond firmly to the commutator surface. As a result, the next brush that passes over this surface will shove a small flake of the material into the commutator slot. This decreases the distance between bars and allows any area formed at the brushes to be more easily carried over to the adjacent set of brushes. Also, this may cause a flashover.

Probable causes of copper drag are as follows:

1. Contaminated atmosphere
2. Copper imbedded in the brush face
3. Hard spot in the brush
4. Wrong grade of brush
5. Excessive vibration

A temporary solution to copper drag is to clean the commutator with a light brush-seater stone. If the copper drag has progressed too far, the bars must be refinished by turning the commutator, and the mica must be undercut. Clean out the commutator slots thoroughly after finding evidence of copper drag. See Fig. 4-9.

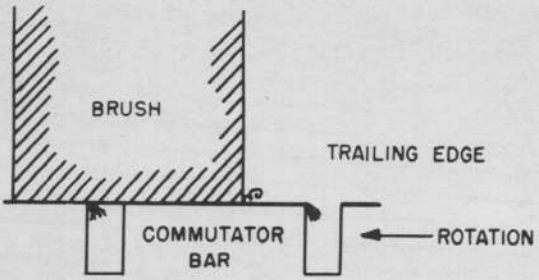


Fig. 4-9 (E-8770)

Fig. 4-9. Copper-drag illustration

BANDING

Banding is a surface defect in the form of bands around the commutator where the surface film has been partially or completely removed. These bands may be narrow or they may extend over a large percentage of the brush path. The bands are readily visible.

Possible causes of banding are as follows:

1. Too heavy brush film (film rolls up)
2. One wrong brush
3. Hard spot in the brush

The banding condition can be corrected by resurfacing the commutator after the cause has been discovered and corrected. See Fig. 4-10.

OTHER COMMUTATOR DEFECTS

Several commutator defects that cannot be corrected unless the armature is removed from the device are listed.

1. Eccentric (out of round) commutator

ROTATING EQUIPMENT

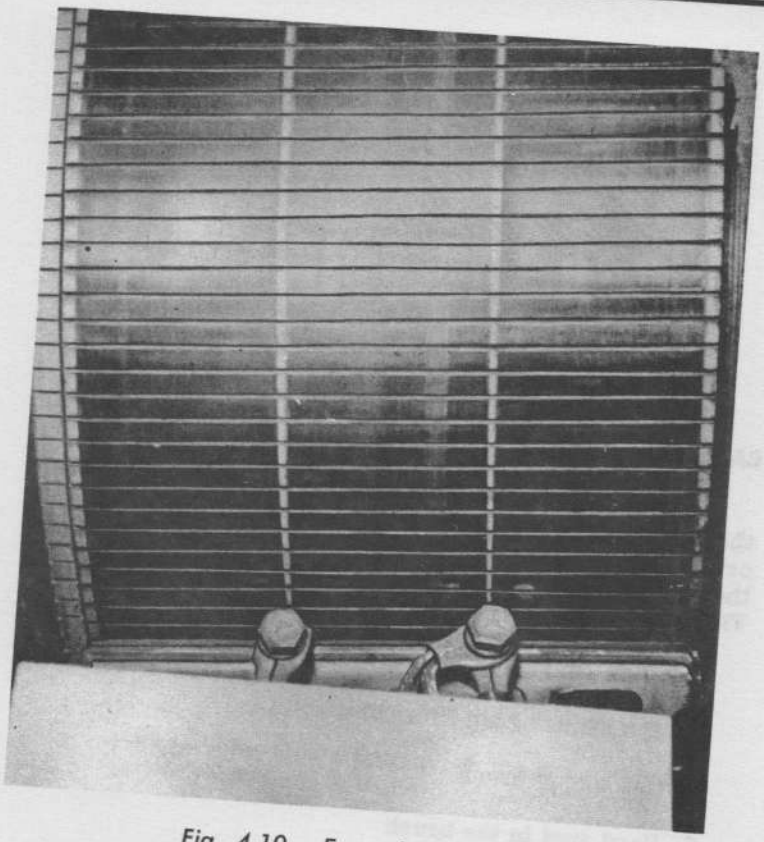


Fig. 4-10 (E-8771)

Fig. 4-10. Example of banding

2. Depressed commutator bars

3. Raised commutator bars

4. Copper segments worn so that the mica requires undercutting

5. Commutator severely damaged by a flashover or mechanical blow

6. Solder thrown from the connections at the risers

When any of the preceding faults are noticed, the equipment should not be run until disassembled and the commutator properly repaired.

COMMUTATOR POLISHING

Commutator surfaces that are merely smudged can usually be polished with a canvas cloth. When this is not sufficient, or if the commutator is slightly rough, crocus cloth, fine (4/0) sandpaper, or 400A Triemite † paper may be used. The abrasive paper used should be mounted on a wooden block which is curved to fit the surface of the commutator. See Fig. 4-11.

CAUTION: *NEVER USE EMERY CLOTH ON A COMMUTATOR. THE ABRASIVE PARTICLES NOT ONLY SCRATCH THE SURFACE BUT ALSO LODGE BETWEEN THE SEGMENTS. EMERY CLOTH ALSO MAY INDUCE SHORT CIRCUITS.*

†Registered Trade-mark of the Minnesota Mining & Mfg. Co.

Fig. 4-11 (E-8778)

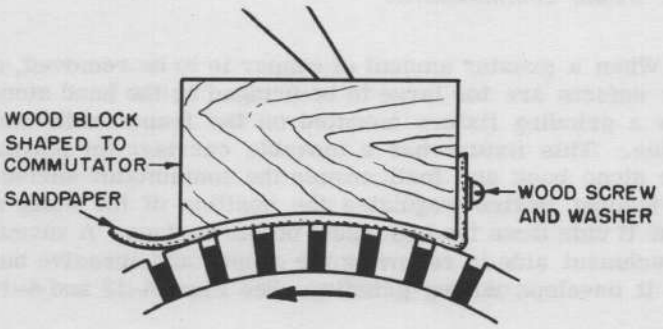


Fig. 4-11. Commutator sanding block

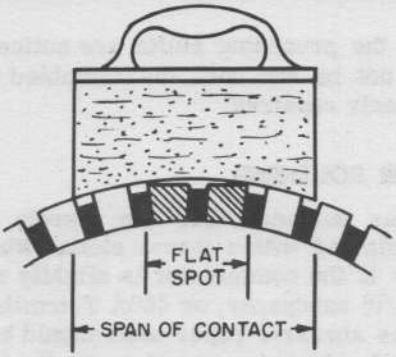


Fig. 4-12. Proper use of hand stone

Fig. 4-12 (E-8779)

COMMUTATOR STONING

If the commutator surface is slightly grooved, etched, or burned, and only a small amount of copper needs to be removed to correct the defect, a hand stone may be suitable for resurfacing. The stone must have a surface curved to fit the commutator and should be long enough to bridge the defects to be removed. The length of the stone is limited by the space between the brush holders. If the space between brush holders is not sufficient, remove one holder. See Fig. 4-12.

NOTE: *Hand stoning will not correct out-of-round commutators.*

When a greater amount of copper is to be removed, or the defects are too large to be bridged by the hand stone, use a grinding fixture mounted on the frame of the machine. This fixture has a movable carriage for passing the stone back and forth across the commutator surface. A feeding device regulates the position of the stone so that it cuts down the high spots on the surface. A vacuum attachment aids in removing the copper and abrasive dust as it develops during grinding. See Figs. 4-13 and 4-14.

The grinding fixture can be used to correct a commutator that is out-of-round.

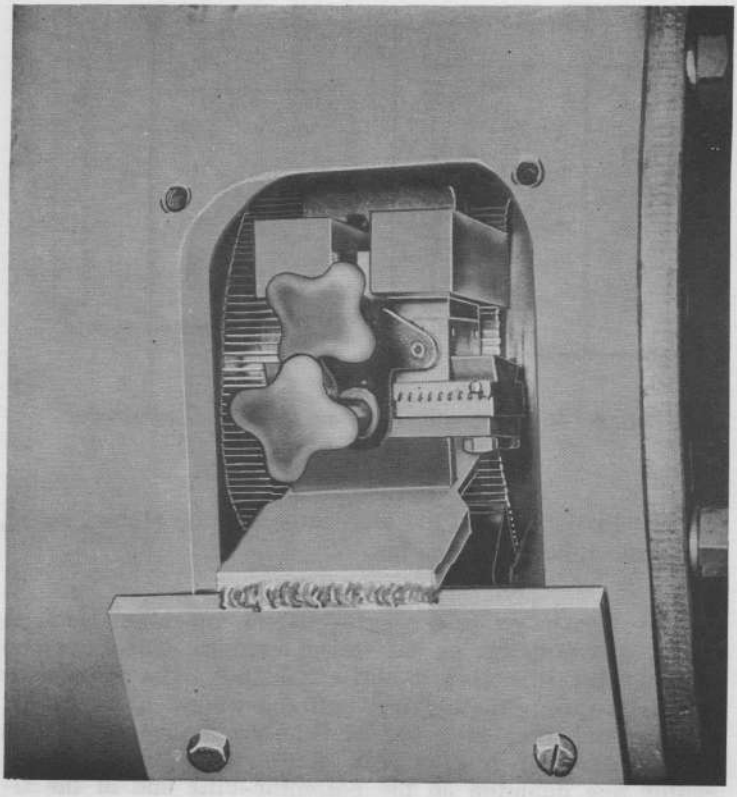


Fig. 4-13 (E-498)

Fig. 4-13. Motor-commutator grinding fixture

TRACTION ALTERNATOR (TA)

INTRODUCTION

The GTA-9 traction alternator is a 12 salient-pole, rotating-field, three-phase, "Y"-connected, separately excited, self-ventilated, a-c machine which converts mechanical energy into a-c electrical power. This a-c power is rectified and drives the locomotive d-c traction motors.

ROTATING EQUIPMENT

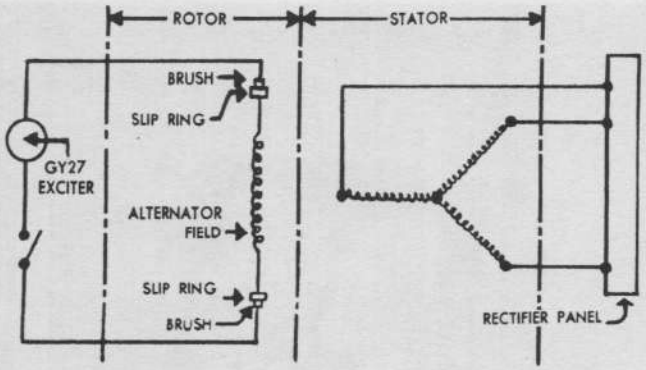


Fig. 4-14. Schematic diagram for GTA-9 alternator

Fig. 4-14 (E-12762)

Principal parts of the alternator are the stator, rotor, framehead, bearing, and fan.

The alternator is a single-bearing machine which is mounted, overhung, on the diesel engine. The drive end of the rotor is bolted to the crankshaft. The crankshaft supports approximately one half the weight of the rotor, and the collector-ring end of the rotor is supported by a roller bearing. A gear unit, exciter, and auxiliary generator are mounted on the collector-ring end of the alternator.

Operating principle of the alternator is as follows: The d-c output voltage of the GY-27 exciter energizes the alternator field windings on the rotor to set up a rotating magnetic field. This rotating field causes a-c to be induced in the alternator stator windings. The a-c from the stator windings is then rectified (full wave) by panel-mounted rectifiers, and the resulting direct current drives the d-c traction motors on the locomotive. A schematic diagram of the alternator is shown in Fig. 4-14, and a typical arrangement of the accessories is shown in Fig. 4-15.

ROTATING EQUIPMENT

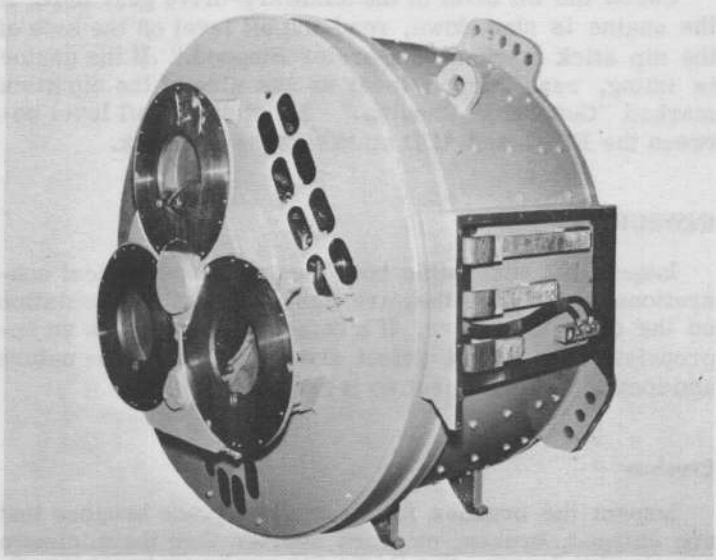


Fig. 4-15 (E-12761)

Fig. 4-15. Alternator accessories mounting arrangement

TOOLS, MATERIALS, AND EQUIPMENT

Following is a list of items required to maintain the alternator:

1. Brush seater, soft grade, 1 1/8 x 5/8 x 4 3/4 inches Cat. 23-008S, Ideal Industries Inc. or equivalent.

2. Spring scale, 0-6 pound capacity, 7 1/4-inches long, John Chatillon & Sons, 87 Cliff Street, New York, N.Y.

LUBRICATION

The fan end of the rotor is supported by a main engine-bearing. The collector-ring end of the rotor is supported by a roller bearing which is splash lubricated from the auxiliary-drive gear unit.

ROTATING EQUIPMENT

Check the oil level of the auxiliary-drive gear unit. If the engine is shut down, read the oil level on the side of the dip stick marked "Generator Stopped." If the engine is idling, read the oil level on the side of the dip stick marked "Generator Running." Maintain the oil level between the FULL and ADD marks on the dip stick.

INSPECTION

Inspect all accessible bolts, nuts, and electrical connections to be sure they are tight. Inspect the insulation on the coils and cables. If a defect is found, make an appropriate note on the defect sheet, indicating the nature and location of the defect so it can be repaired.

Brushes

Inspect the brushes for wear and replace brushes that are chipped, broken, or worn shorter than the minimum permissible length. See DATA for minimum brush length. Be sure that the brushes are long enough to last until the next inspection.

Brush Holders

Inspect the brushholders and replace damaged or broken pressure springs, frayed brush pigtails, and bent pressure arms. Move the brushes up and down several times in the holders to release carbon dust or foreign matter from the carbonways and to assure free movement of the brushes. Inspect the connection-strap bolts, nuts, and clamps. Inspect the connection-strap insulation for cracks or other damage. Inspect the field and stator insulation for cracks or other damage.

MAINTENANCE

There is very little maintenance on this alternator. Observe the following maintenance procedures (in addition to your regular inspection and maintenance).

Cleaning

1. Use dry, clean, compressed air (35-pounds pressure maximum) and blow out the interior of the alternator during the monthly inspection period. This will help to keep dirt and foreign matter from building up on the interior surfaces of the alternator.

2. Clean the dirt from around air openings, lubricant filler caps, and drain plugs.

3. Wipe the brush-stud insulators and the collector-ring bands with a clean, dry cloth.

4. Look for loose electrical connections while cleaning.

Installing New Brushes

CAUTION: *WHEN REPLACING BRUSHES, USE THE GENERAL ELECTRIC RECOMMENDED GRADE. MIXING OF BRUSH GRADES IN THE SAME ALTERNATOR, OR CHANGING BRUSHES TO ANOTHER GRADE, COULD SERIOUSLY AFFECT THE SURFACE FILM ON THE COLLECTOR RINGS AND BRUSH LIFE.*

Install new brushes as follows:

1. Unlatch the brush pressure-spring and remove the pigtail terminal from the brushholder. Lift the pressure arm and remove the old brush.

2. Do not mix brush grades. Lift the pressure arm and insert a new brush in the holder. When installing brushes, make sure the brush pigtails face toward the auxiliary end of the alternator.

3. Push the pigtail terminal under the brushholder terminal-screw and tighten the screw. Latch the brush pressure-spring.

4. Pigtails must be positioned vertically above the brush as shown so they will not touch or hang on the edge of the brush box as brush wear occurs.

NOTE: *When new brushes are installed, sand the brushes to the contour of the collector rings and use a seater stone to assure proper brush contact on the collector rings.*

Seating New Brushes

Sand the brushes as follows:

1. Place a strip of fine sandpaper (abrasive side toward brush) between the collector ring and the brush. Pull the sandpaper in the direction of rotor rotation with normal spring tension on the brush.

2. Keep the ends of the sandpaper in contact with the collector ring to avoid rounding the edges of the brush. Lift the brush after each cutting stroke and move the sandpaper back to the starting position. Repeat steps 1 and 2 to make the radius of the brush match the radius of the collector ring.

3. Use dry, compressed air (35-pounds pressure maximum) and blow carbon dust out of alternator after sanding the brushes.

Use a seating stone as follows:

WARNING: *THERE IS NO HAND CLEARANCE ABOVE THE REAR COLLECTOR RING (THE ONE NEXT TO THE ROTOR CORE) TO HAND-HOLD A BRUSH-SEATER STONE. TAPE THE SEATER STONE TO A STICK OF WOOD BEFORE ATTEMPTING TO SEAT THE BRUSHES ON THE COLLECTOR RING LOCATED NEXT TO THE ROTOR.*

1. With the engine at idle speed, press the seater stone (which has been taped to a stick of wood) against the surface of the rear collector ring. Apply moderate pressure to obtain cutting action of the stone. The brushes on the front collector ring may be seated with a hand-held brush-seating stone.

2. When the brushes are seated, shut down the engine. Use dry, compressed air (35-pounds maximum) to blow the dust out of the alternator.

3. Lift each brush, and air-clean the contact surfaces of the brush and the collector ring.

Brush-holder Clearance

Check the clearance between the bottom of the brush-holders and the surface of the collector rings. If the clearance between the brushholder and the collector ring is not within the limits of 3/32 to 1/8 inch, reset the brush-holder to the nominal dimension (0.100 inch) as follows:

1. Unlatch the brush pressure-spring and remove the brush from the holder. Loosen the brush-stud capscrew located on the brushholder yoke and place a 0.100-inch shim between the bottom of the brushholder and the collector ring.

2. Move the brushholder down against the fiberboard shim and tighten the brush-stud cap screw.

3. Remove the fiberboard shim, slip the brush into the holder and latch the pressure spring. Make sure the pigtail terminal-screw is tight and pigtails are in the correct position.

ROTATING EQUIPMENT

DATA

MODEL 5GTA9C1

RESISTANCE AT 25 C (NOMINAL)
- Rotor . . . . . 0.262 ohms
- Stator – T1 to T2 . . . . . 0.00256 ohms
  - T2 to T3 . . . . . 0.00256 ohms
  - T1 to T3 . . . . . 0.00256 ohms

WEIGHTS
- Alternator (less auxiliaries and auxiliary-drive gear assembly) . . . . . 14,810 lb
- Auxiliary Generator (5GY27F1) (2 per alternator, 700 lb each) . . . . . 1,400 lb
- Auxiliary-drive Gear Assembly . . . . . 360 lb
- Gear Unit (7GA55B1) . . . . . 530 lb
- Alternator with Auxiliaries and Auxiliary-drive Gear Assembly . . . . . 17,100 lb

ROTATION . . . . . CCW (facing slip-ring end)

BRUSH DATA
- Minimum Length (length at which brush becomes inoperative) . . . . . 1 3/16 inch
- Spring Pressure (new brush) . . . 4 1/4 lb to 4 3/4 lb

BRUSHHOLDER
- Clearance to Collector Ring (Nominal) . . . 0.100 inch

COLLECTOR RING
- Minimum Permissible Diameter . . . . . 14 3/4 inches
- Run Out . . . . . 0.0015 inch

LUBRICATION
- Auxiliary-drive Gear Assembly Capacity (initial filling, approximately) . . . . . 5 pints
- Lubricant (low foam type) . . SAE-40 Engine Lube Oil MIL-L-2104A

AUXILIARY GENERATOR (AG) AND ALTERNATOR EXCITER (EXC)

INTRODUCTION

The GY-27 auxiliary generator (AG) is a four-pole, commutating-pole, shunt-wound, d-c generator that provides regulated power for operation of control equipment, lights, and battery charging.

The GY-27 alternator exciter (EXC) is a four-pole, commutating-pole, shunt-wound machine used for exciting the traction alternator (generator).

NOTE: *In the following descriptions, the traction alternator shall be referred to as the traction generator.*

Each GY-27 is mounted on the traction gear box and is driven through the gear box by a pinion mounted on the end of the shaft.

INSPECTION

1. Inspect the brushes for condition and amount of wear. Replace any brushes that are chipped, broken, or worn near the minimum length.

CAUTION: *WHEN REPLACING BRUSHES, USE THE GENERAL ELECTRIC RECOMMENDED GRADE. MIXING OF BRUSH GRADES IN THE SAME MACHINE, OR CHANGING BRUSHES TO ANOTHER GRADE, COULD SERIOUSLY AFFECT COMMUTATION, SURFACE FILM AND BRUSH LIFE.*

2. Inspect the condition of the commutator. It must have a smooth, polished surface. Refer to COMMUTATOR MAINTENANCE under GENERAL MAINTENANCE.

3. Inspect the brush holders for damage from burning, flashovers, etc. Look for damaged pressure springs, shunts, or levers.

4. See that all electrical lead connections are tight. See that overheating has not caused solder to flow from the soldered connections.

5. Check the insulation resistance of the armature and field coils using a megohmmeter. Insulation that has a resistance reading below one megohm is in need of cleaning and baking.

RESURFACING COMMUTATOR

Resurface a worn, grooved, or burned auxiliary-generator commutator by using a grinder Catalog 481A152P1. Proceed as follows:

1. Remove oil and dirt from the exposed insulation surfaces around the commutator.

2. Position the grinder in the auxiliary generator as shown in Fig. 4-16. It is necessary to remove the two adjacent top brush holders to install the grinder.

3. Remove or lift all brushes to prevent wearing away and creating carbon dust.

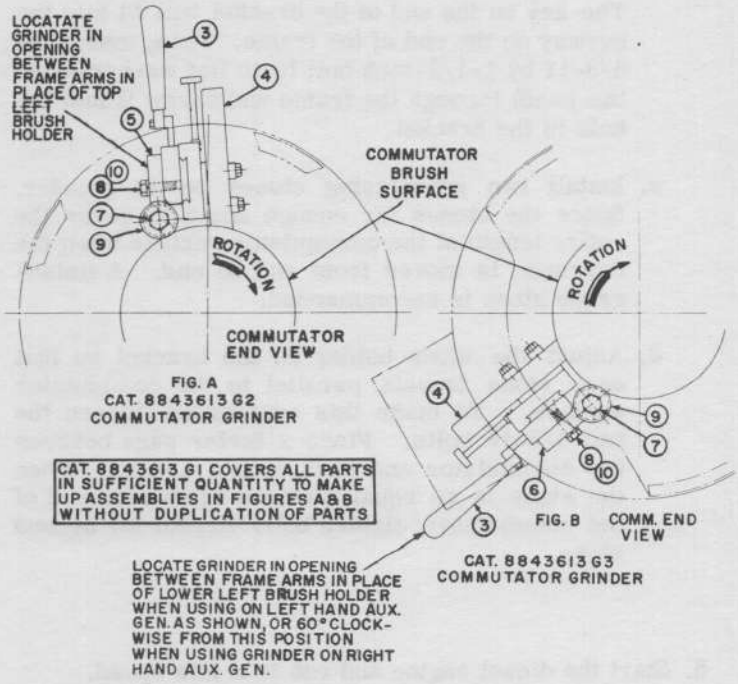
4. Install the commutator grinder in the auxiliary generator as follows:

   a. Assemble the grinder to the exciter mounting bracket with the two 3/8-16 by 1-3/8-inch bolts.

   b. Install the mounting bracket and grinder in the machine where the brush holder was removed.

ROTATING EQUIPMENT

Fig. 4-16 (P-88436-13)


LOCATATE GRINDER IN OPENING BETWEEN FRAME ARMS IN PLACE OF TOP LEFT BRUSH HOLDER
COMMUTATOR BRUSH SURFACE
ROTATION
COMMUTATOR END VIEW
FIG. A
CAT. 8843613 G2
COMMUTATOR GRINDER
CAT. 8843613 G1 COVERS ALL PARTS IN SUFFICIENT QUANTITY TO MAKE UP ASSEMBLIES IN FIGURES A&B WITHOUT DUPLICATION OF PARTS
ROTATION
FIG. B
COMM. END VIEW
CAT. 8843613 G3
COMMUTATOR GRINDER
LOCATE GRINDER IN OPENING BETWEEN FRAME ARMS IN PLACE OF LOWER LEFT BRUSH HOLDER WHEN USING ON LEFT HAND AUX. GEN. AS SHOWN, OR 60° CLOCKWISE FROM THIS POSITION WHEN USING GRINDER ON RIGHT HAND AUX. GEN.

1 Assembly, Fig. A
2 Assembly, Fig. b
3 Commutator grinding
4 Resurfacing stone
5 Mounting bracket
6 Mounting bracket
7 Cap screw hex hd.
8 Cap screw hex hd.
9 Flat washer
10 Lock washer

Fig. 4-16. Positioning auxiliary-generator commutator grinder

The key on the end of the bracket will fit into the keyway on the end of the frame. Then, insert the 5/8-11 by 1-1/2-inch bolt (with flat washer under the head) through the frame and screw it into the hole in the bracket.

c. Install two resurfacing stones on the grinder. Space the stones far enough apart to cover the entire length of the commutator surface when the carriage is moved from end to end. A finish-grade stone is recommended.

d. Adjust the stone holder on the bracket so that each stone travels parallel to the commutator surface. To make this adjustment, loosen the two 3/8-16 bolts. Place a feeler gage between the commutator and each end of a stone. When the stone is an equal distance from each end of the commutator, tighten bolt. Repeat for second stone.

5. Start the diesel engine and run it at idle speed.

6. Advance the stones to take a light cut across the commutator surface to check the alignment. Stones should cut approximately the same amount at front and riser end of the commutator. If the depth of cut is not uniform, re-adjust the grinder until the cut is even at both ends of the commutator.

7. Traverse the grinder and advance the stones until the commutator is cleaned up. Take moderate cuts and, if possible, vacuum the copper dust particles as they are formed.

8. Make light finishing cuts and, after ending depth feed, traverse along the commutator several more times to obtain a smooth finish. Shut down the diesel engine and remove the grinder from the machine.

9. Use an engraving tool to remove the ragged edges left along the edges of the commutator bars. Use a stiff bristle brush to clean out the commutator slots.

10. Run the diesel engine at idle speed and blow out all copper dust with dry compressed air.

11. Check the commutator run-out after stoning. Maximum allowable run-out is 0.001 inch.

LUBRICATION

The pinion-end bearing is splash-lubricated by oil from the traction-generator gear box. Check the oil level in the gear box when the engine is shut down and the threads of the dip stick cap are disengaged. Add heavy-duty lubricating oil to the FULL mark. DO NOT OVERFILL.

DATA

RESISTANCE AT 25 C (77 F) (AVERAGE)

Armature	0.0229 ohm
Shunt Field	8.80 ohms
Commutating Field	0.00915 ohm
Aluminum Comm. Coils	0.0130 ohm

BRUSH DATA

Pressure	43 to 53 oz
Minimum Length (length where brush becomes inoperative)	1 inch
Brush-holder clearance to commutator	1/16 to 3/32 inch

COMMUTATOR DATA

Minimum permissible diameter	7 1/2 inch
Maximum commutator run-out	0.001 inch

ROTATING EQUIPMENT

TRACTION MOTOR

INTRODUCTION

The GE-752 traction motor is a four-pole, commutating-pole, series-wound, d-c motor. The traction motor converts the electrical power delivered by the traction generator into mechanical power to drive the wheel through a spur pinion on the armature shaft. This pinion meshes with a gear pressed on the locomotive axle. A gear case bolted to the traction motor surrounds the pinion and gear. This case is used to exclude dirt and moisture while retaining the necessary gear lubricant.

When the locomotive circuits call for dynamic braking, the traction motors act as generators. This action slows down the locomotive when descending a grade by exerting a retarding effect on the locomotive axles.

INSPECTION

1. Inspect the brushes for condition and amount of wear. Replace any brushes that are chipped, broken, or worn near the minimum length. Be sure brushes move freely in the holders.

> **CAUTION:** *WHEN REPLACING BRUSHES, USE THE GENERAL ELECTRIC RECOMMENDED GRADE. MIXING OF BRUSH GRADES IN THE SAME MACHINE, OR CHANGING BRUSHES TO ANOTHER GRADE, COULD SERIOUSLY AFFECT COMMUTATION, SURFACE FILM, AND BRUSH LIFE.*

2. Inspect the condition of the commutator and wipe off string band. The commutator must have a smooth, polished surface. Refer to COMMUTATOR MAINTENANCE under GENERAL MAINTENANCE.

3. Inspect the brush holders for damage from burning, flashovers, etc. Look for damaged pressure springs, shunts, or levers.

4. See that all electrical lead connections are tight. See that overheating has not caused solder to flow from the soldered connections.

5. Check and adjust the brush-spring pressure. Check the clearance between the bottom of the brush holder and the surface of the commutator. See DATA for distance.

6. Examine the flash ring for damage. It should be kept clean and free from paint or taped insulation.

LUBRICATION

1. Remove, clean, and inspect the axle-cap felt-wick lubricators as follows:

a. Remove the complete carrier plate and wick assembly from the axle cap. See Fig. 4-17.

b. Remove the cotter pin from one end of the spring-support pin and pull the pin out of the carrier plate assembly. This releases the spring support and wick-positioning springs. These can now be removed through the bottom of the carrier plate assembly.

c. Remove the wick assembly from the carrier-plate assembly. Do not remove the wick from the wick holder as it cannot be replaced. New wicks are supplied with the wick holder assembled.

d. Clean the wicks by soaking them for two hours in standard car oil heated to 120 to 140 F.

e. Discard the wick lubricator if the lubricating surface is burned or damaged. Test the wick by

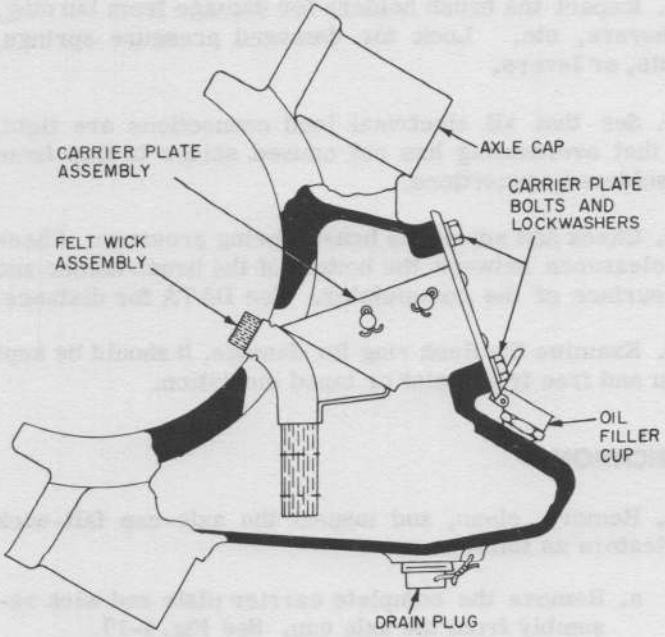


Fig. 4-17 (E-13328)

Fig. 4-17. Axle-cap assembly

applying clean oil to the lubricating surface. If oil is quickly absorbed, the wick is still operative. Discard the wicks when they are worn to within 1/4 inch of the metal wick holder. See Fig. 4-18.

f. Maintain the oil level to the bottom of the oil filler cup. Use car oil, AAR Specification M-806-56.

2. Check the level of the traction-motor gear-box lubrication compound while the compound is hot and in a fluid state. Add compound necessary to bring the level up to the bottom side opening. DO NOT OVERFILL. Use General Electric Specification D50E8C Compound.

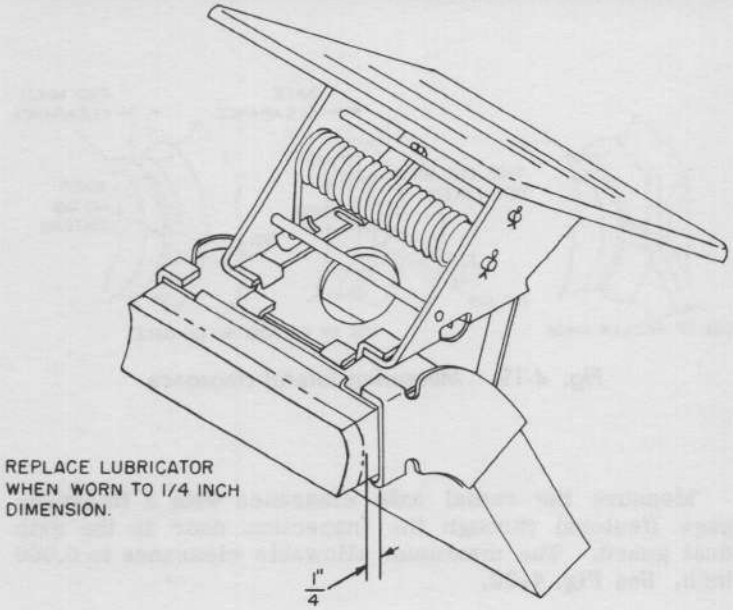


Fig. 4-18 (E-8502A)

Fig. 4-18. Condemning limit for felt-wick lubricator

AXLE BEARING CLEARANCE

Periodically, measure the end-play of the motor on the axle and radial clearance of the axle linings.

To measure end-play, force the motor toward the gear by prying between the nose suspension and truck bolster. Measure the end-play (lateral clearance) through the drain hole in the axle-flange dust guard at the commutator end. Use feeler gages as shown in Fig. 4-19. If the gear lubricant has frozen the pinion to the gear so that the motor cannot be barred sidewise, add clearance at each end of the motor to get total lateral clearance. Clearance at the pinion end can be measured between the gear hub and axle-lining flange by inserting a feeler through the drain hole in the gear-case seal. Maximum end-play allowed is 1/8 inch per lining flange, or 5/16-inch total.

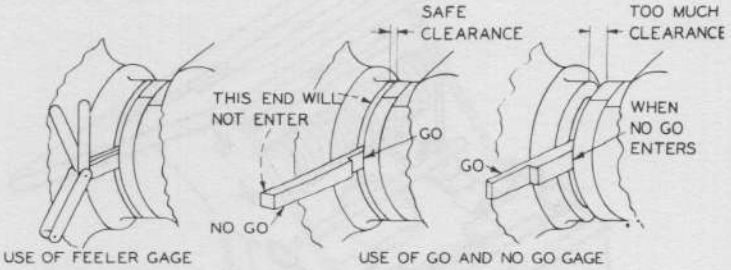


Fig. 4-19. Measuring lateral clearance

Fig. 4-19 (E-6025)

Measure the radial axle clearance with a thickness gage (feelers) through the inspection door in the axle dust guard. The maximum allowable clearance is 0.060 inch. See Fig. 4-20.

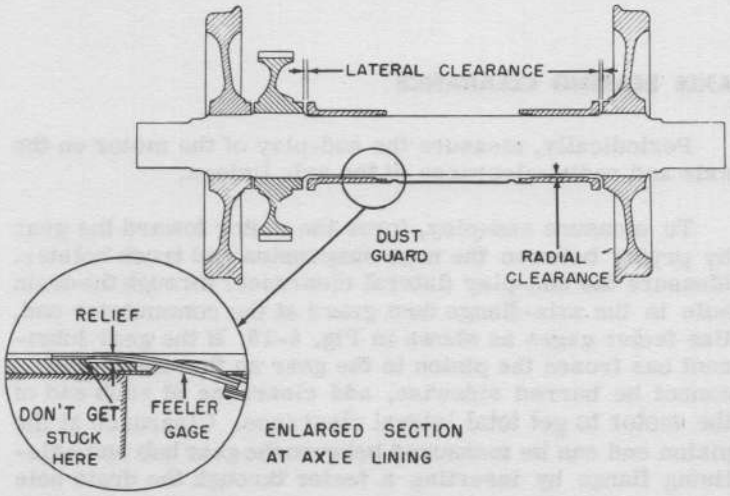


Fig. 4-20. Measuring radial axle-bearing clearance

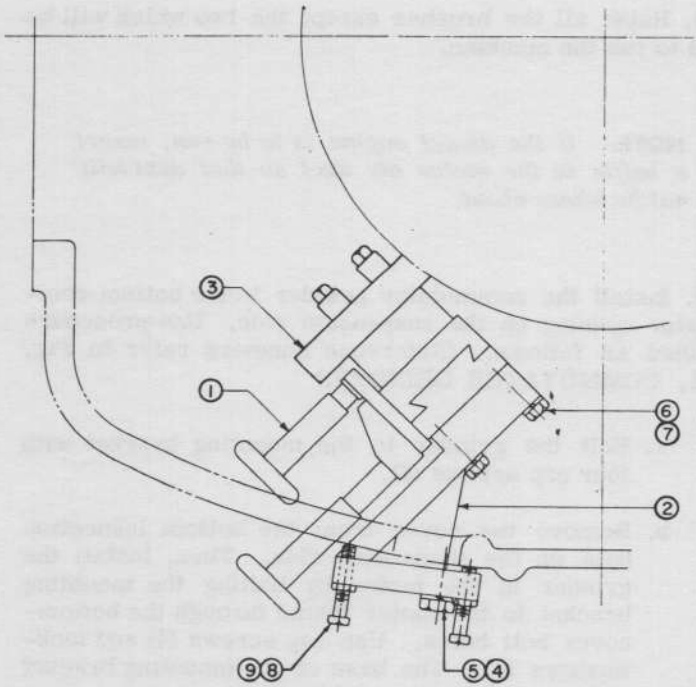
Fig. 4-20 (E-6027)

ROTATING EQUIPMENT

RESURFACING COMMUTATOR

The resurfacing of a worn, grooved, or burned commutator may be accomplished by using grinder assembly, Catalog 8837582G1, which is comprised of grinder (Catalog 8828708P1), mounting bracket (Catalog 8843149P6), and stones (Catalog 8824492P8). Proceed as follows: (See Fig. 4-21)

Fig. 4-21 (E-5981)



1 Commutator grinding
2 Mounting bracket
3 Resurfacing stone
4 Cap screw
5 Lock washer
6 Cap screw
7 Lock washer
8 Set screw
9 Jam nut

Fig. 4-21. Commutator grinder

ROTATING EQUIPMENT

1. Place the locomotive over a pit and cut out the air brakes on the truck to be worked on. Block the wheels on all axles not being worked on so that the locomotive cannot move. Set the air brakes on these trucks.

2. Place a wooden block between the pedestal tie bars and the journal boxes of axle to be rotated. The block must be thick enough to take up all the space. Jack up the ends of the truck until the wheels clear the rails.

3. Raise all the brushes except the two which will be used to run the machine.

NOTE: *If the diesel engine is to be run, insert a baffle in the motor air duct so that dust will not be blown about.*

4. Install the commutator grinder in the bottom commutator opening on the suspension side. Use procedure outlined as follows: (Reference numbers refer to Fig. 4-21. COMMUTATOR GRINDER.)

a. Bolt the grinder to the mounting bracket with four cap screws (6).

b. Remove the cover from the bottom inspection hole on the suspension side. Then, install the grinder in the motor by bolting the mounting bracket to the motor frame through the bottom-cover bolt holes. Use cap screws (4) and lock-washers (5). The base of the mounting bracket will be on the outside of the frame.

c. Place the two jam nuts (9) on set screws (8) and screw them into the tapped holes in the corners of the mounting-bracket base. These are used to adjust the grinder position with respect to the commutator.

d. Assemble the resurfacing stones in the grinder. See Fig. 4-22. These stones must cover the entire width of the commutator, when the grinder is traversed from side to side, and still overlap in the center.

e. After the stones are installed, traverse the grinder to the end of the commutator and check the clearance between the commutator surface and one stone. Use a feeler gage. Clearance should be the same between the stone and commutator at either end of the commutator. If the clearance is different, adjust the mounting-bracket set screws (8) until the clearance is uniform. Tighten the jam nuts (9).

f. Turn the feed control to back the stones away from the commutator until the commutator is turning.

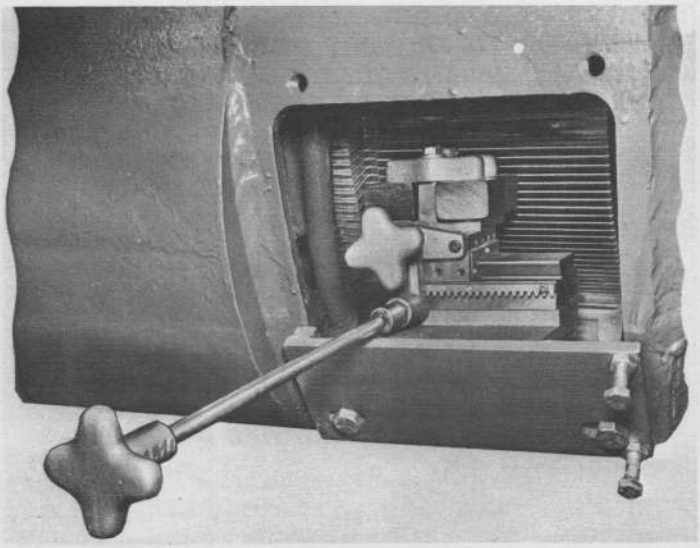


Fig. 4-22 (E-10677)

Fig. 4-22. Midget commutator grinder installed in GE-752 motor

5. Connect the motor to a source of power suitably controlled to drive it at a speed of 1000 to 1500 rpm. This can be done by using an outside source of power or power from the main generator.

a. To use power from an outside source, disconnect the motor leads from the locomotive wiring and connect as a series motor to a generator such as a 3 to 5-kw, 100-volt welding set. See Fig. 4-23.

b. To use the diesel-electric locomotive power plant, block all wheels except those connected to the motor being stoned. The motor can be run without disturbing the locomotive connections by placing the throttle in the first operating position. The current required to run the motor is so low that no damage will result to the blocked motors through which current will flow.

WARNING: *TO PROTECT PERSONNEL FROM PHYSICAL HARM, THE FOLLOWING SAFETY PRECAUTIONS MUST BE ADHERED TO:*

(a) BLOCK THE LOCOMOTIVE WHEELS TO PREVENT ANY MOVEMENT DURING GRINDING OPERATIONS.

(b) AN ASSISTANT MUST BE AT THE LOCOMOTIVE CONTROLS TO REMOVE POWER IN EVENT OF AN EMERGENCY.

(c) GRINDER OPERATOR MUST WEAR PROTECTIVE COVER OVER FACE AND EYES WHEN GRINDING OR BLOWING WITH COMPRESSED AIR.

6. Apply power to rotate the motor armature at 1000 to 1500 rpm.

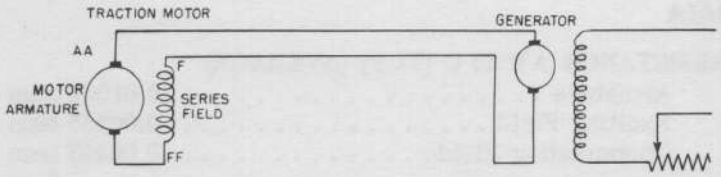


Fig. 4-23 (E-671)

Fig. 4-23. Connection to run traction motor from welding set

7. Move the fixture back and forth along the commutator, and slowly advance the stones toward the commutator surface until they start to remove copper. Continue to advance the stones, using extreme caution to get proper feel and to avoid chatter.

8. Grind the commutator until a uniformly smooth surface is obtained and flat spots have been removed. Do not remove more copper than is necessary.

9. Check the brushes frequently during the grinding operation. Change the brushes if they begin to spark badly.

10. After the final cut, traverse the stones back and forth longitudinally, without changing the feed, until there is no more cutting action. Shut off power.

11. Scrape out the slots between the bars to remove any projecting mica fins or copper whiskers dragged over from the edge of the bars.

12. Polish the commutator with 00 sandpaper.

13. Blow out copper and carbon dust from the motor interior, using dry compressed air. Hold the end of the hose two or three inches from commutator and sweep it longitudinally along slots.

14. Replace the brushes and return the motor to the service condition.

ROTATING EQUIPMENT

DATA

RESISTANCE AT 25 C (77 F) (AVERAGE)

Armature	0.01002 ohm
Exciting Field	0.00555 ohm
Commutating Field	0.00592 ohm

BRUSH DATA

Pressure	10 to 12 lb
Minimum Length (length where brush becomes inoperative)	1 3/32 inch
Brush holder clearance to commutator	1/16 to 3/32 inch

COMMUTATOR DATA

Minimum Permissible Diameter	15 3/8 inch
Maximum Commutator Run-out	0.002 inch

GEAR UNIT

INTRODUCTION

The Type GA-57 gear unit is a single step-up, right-angle drive unit which transmits mechanical power from the diesel engine to the radiator fan. The radiator fan is connected to the vertical shaft and is driven, through gearing, by the horizontal shaft. The horizontal shaft is connected to the diesel engine through a flexible coupling.

The horizontal and vertical shafts are supported by ball and tapered roller bearings. The gears and the bearings on the horizontal shaft and the lower end of the vertical shaft are splash lubricated with oil that is contained in the gear box. The ball bearing at the upper end of the vertical shaft is grease lubricated. An inspection cover on the side of the bear gox provides access to the gears.

ROTATING EQUIPMENT

LUBRICATION

Gears and Horizontal Shaft Bearings

Remove the filler cap and fill the gear unit with specified oil until the oil is level with the filler-cap opening (see Fig. 4-24). The capacity of the gear unit is 12-1/2 quarts.

Maintain the oil level so that it is not more than one inch below the filler-pipe opening, measuring along the inside surface of the pipe as shown in Fig. 4-24. Failure to maintain this level may result in improper lubrication and damage to the gears and bearings.

The gear unit should be drained and refilled with new oil annually or when the gear unit has been removed for overhaul or repair.

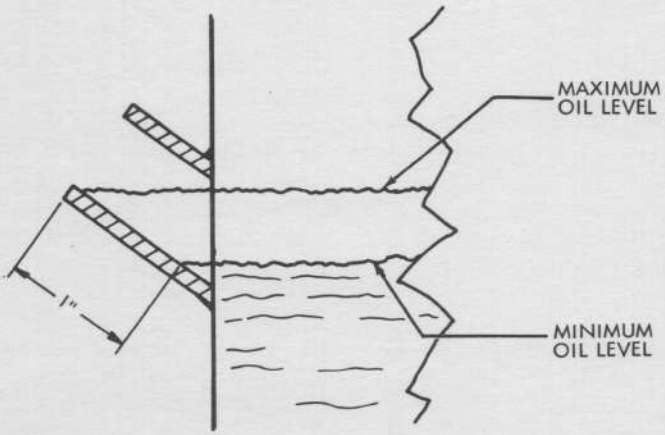


Fig. 4-24 (E-12825)

Fig. 4-24. Measuring oil line

ROTATING EQUIPMENT

DATA

MODEL 5GA57A1

GEARING
- Type ..... Bevel
- Ratio ..... 1.0 to 1.023
- Backlash-Rotational backlash measured at radius of 3.625 from the center of the vertical shaft ..... 0.006 - 0.008

BEARINGS
- Type ..... Ball and Tapered Roller
- Endplay - Horizontal Shaft..... 0.002 to 0.005 inch

LUBRICANT
- Oil - Capacity ..... 12-1/2 quarts
- Oil Type .....SAE 40 Engine Oil
- Grease - Type..... D6A2C4

WEIGHT (Approximate)
- Complete Unit ..... 860 lb

AIR-BRAKE EQUIPMENT

DESCRIPTION

The schedule 26-L equipment arranged for single-end multiple-unit operation is normally used on the locomotive. The principal parts are:

1. 26-C Automatic Brake Valve
2. SA-26 Independent Brake Valve
3. Brake-valve Cut-out Cock (Cut-off Pilot Valve)
4. MU-2A Valve
5. 26-F Control Valve

26-C AUTOMATIC BRAKE VALVE
(See Figs. 5-1 and 5-2)

The Automatic Brake valve regulates brake-pipe pressure, to control both locomotive and train brakes. It has six handle positions, from left to right, as follows:

1. RELEASE (Running) Position

The handle in this position charges the equipment and releases the locomotive and train brakes after an Automatic application. The charging and releasing is accomplished by controlling air pressure in the brake pipe, set by the position of the Regulating Valve handle (on back of brake stand). The RELEASE position is at the extreme left of the quadrant and is the normal position when the Automatic brake is not in use.

2. MINIMUM REDUCTION Position

This is located to the right of the RELEASE position where the Brake Valve handle reaches the first raised portion of the quadrant. With the handle moved to this position, a light Service application is obtained which results in a five- to seven-pound brake pipe reduction.

AIR EQUIPMENT

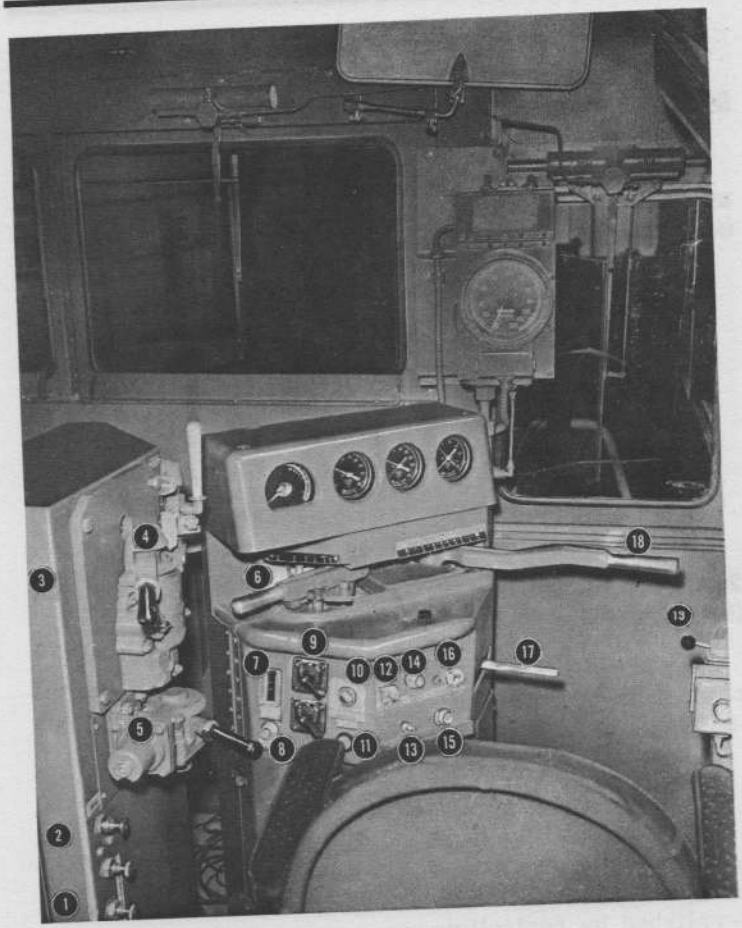


Fig. 5-1 (E-13361)

Fig. 5-1. Engineman's position

3. SERVICE Position

This is a sector of the Brake Valve handle quadrant to the right of the MINIMUM REDUCTION position. Moving the handle from left to right in this sector increases the degree of a brake application. At the extreme right of the sector, a Full-Service brake application is obtained.

AIR EQUIPMENT

NOMENCLATURE FOR FIG. 5-1

1 Window wiper motor controls
2 Bell ringer control
3 Air regulating valve (Feed Valve)
4 Automatic brake valve
5 Independent brake valve
6 Selector handle
7 Generator-field circuit breaker
8 "PCS OPEN" light
9 Headlight switches
10 Emergency shutdown switch
11 Call button
12 Power limit switch
13 Dimmer control
14 Brake warning light
15 Wheel-slip light
16 Light switch
17 Reverse handle
18 Throttle handle
19 Sander control

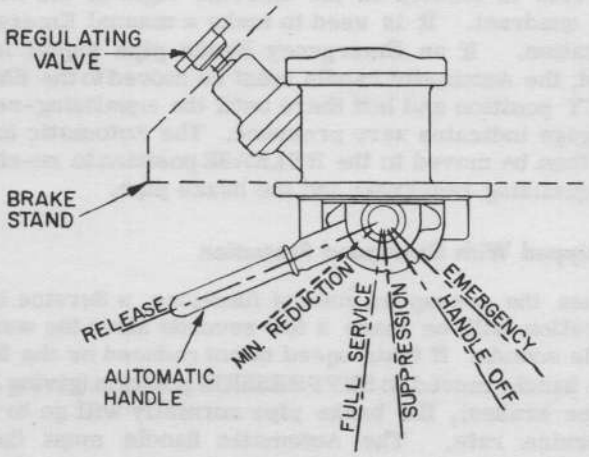


Fig. 5-2 (E-8924D)

Fig. 5-2. Automatic brake-valve handle positions

4. SUPPRESSION Position

This is located with the handle against the second raised position of the quadrant to the right of the RELEASE position. It provides a Full-Service brake application as with the Brake Valve handle in the FULL SERVICE position. In addition, Overspeed Control and Safety Control Penalty brake applications are suppressed on locomotives so equipped.

5. HANDLE - OFF Position

This is located as the quadrant notch to the right of the SUPPRESSION position. If the handle is removable, the brake valve must be placed in this position before removal. On trailing units of a multiple-unit consist or on a locomotive being towed "dead" in the train, the handle must have been located in this position.

6. EMERGENCY Position

This is located to the extreme right of the Brake-valve quadrant. It is used to make a manual Emergency application. If an Emergency Brake pipe signal is received, the Automatic handle must be moved to the EMERGENCY position and left there until the equalizing-reservoir gage indicates zero pressure. The Automatic handle must then be moved to the RELEASE position to re-charge the Equalizing reservoir and the brake pipe.

If Equipped With Overspeed Protection

When the overspeed control functions, a Service brake application will be made a few seconds after the warning whistle sounds. If train speed is not reduced or the Brake Valve handle moved to SUPPRESSION position (giving Full-Service brakes), the brake pipe normally will go to 0 psi at service rate. The Automatic handle must then be brought back to the RELEASE position to re-charge the Equalizing reservoir and the brake pipe.

If Equipped with Safety-control (Deadman) Protection

If the foot pedal is released, a Service brake application will be made a few seconds after the warning whistle sounds. If the pedal is not depressed within this time, a Full-Service brake application will be applied to the train. The Automatic handle must be moved to the SUPPRESSION position to prevent further reduction of the brake pipe pressure. It must then be brought back to the RELEASE position to re-charge the equalizing reservoir and the brake pipe.

If Equipped with Split-reduction Protection

An initial brake pipe reduction of eight psi will be made automatically and held for a period of 20 seconds if the Automatic handle remains in the RELEASE position. This will bunch the train and then the brake pipe will normally go to 0 psi at the service rate. To release the train brakes, move the Automatic handle to the SUPPRESSION position, and, after approximately 30 seconds, move the handle to the RELEASE position. This should re-establish the Equalizing-reservoir pressure at its initial value and re-charge the brake pipe. If Brake Valve handle is moved to the SUPPRESSION position before the 20 seconds have elapsed, the brake-pipe reduction will be limited to the initial eight psi.

SA-26 INDEPENDENT BRAKE VALVE (See Fig. 5-1)

The Independent Brake valve applies and releases the brakes on the locomotive unit only (or by depressing the handle, releases the brakes on the locomotive consist) after an automatic or emergency application.

The Independent Brake valve has two terminal positions, RELEASE and FULL APPLICATION, with a graduated application zone between. The brake valve is of the self-lapping (pressure maintaining) type. The valve automatically stops the flow of air and maintains brake-cylinder pressure when the application pressure reaches the

pressure corresponding to the position of the handle. An Independent brake application can be released only by movement of the Brake Valve handle towards RELEASE position. An Automatic Service or Emergency application can be released on the locomotive consist by depressing the Independent Brake Valve handle in RELEASE position. The Independent Brake Valve handle is normally not removable.

BRAKE-VALVE CUT-OUT COCK (CUT-OFF PILOT VALVE)

This cut-out cock is located on the front of the Automatic brake stand, and normally has two positions marked IN and OUT. The IN position is used when locomotive is in LEAD position in a multiple-unit consist or when the locomotive is operated singly. The OUT position is used when the locomotive is operated as a trail unit in multiple-unit, when hauled "dead-in-train" or in Pusher service. Push in the handle and turn to change positions.

NOTE: *Some railroads use a three-position pilot-valve.*

MU2A VALVE (EQUIVALENT OF ROTAIR VALVE)

Normally, this is a two-position valve located on back of the brake console. It is used to enable a locomotive equipped with 26-L brakes to be operated with locomotives having other types of brake equipment.

The two positions of the MU-2A valve are "LEAD or DEAD"; "TRAIL-24 and 26". Push handle in and turn to change positions.

1. "LEAD or DEAD" position is selected when the locomotive unit is operated singly or when it is the lead unit of a multiple-unit consist. It is also used when the locomotive unit is hauled "dead-in-train".

2. "TRAIL 24 and 26" position is used when the locomotive is trailed behind a locomotive having 24RL or 26L brake equipment.

NOTE: *Some railroads use a three-position MU-2A valve.*

26-F CONTROL VALVE (See Fig. 5-3)

This valve is located in the air brake compartment. When actuated by an Automatic Brake valve through the brake pipe, it operates to charge, apply, and release the brakes. The release cap on the control valve can be mounted in two ways:

1. With letters GRA over word RELEASE it provides "graduated release" of the automatic brakes.

2. With letters DIR over word RELEASE it provides "direct release" of the automatic brakes.

AIR GAGES

Normally, three duplex air gages are located in the gage panel in front of the engineman, and single-pointer air gages are located near the compressor governor and control-air reducing valve. The functions of the duplex gages are as follows:

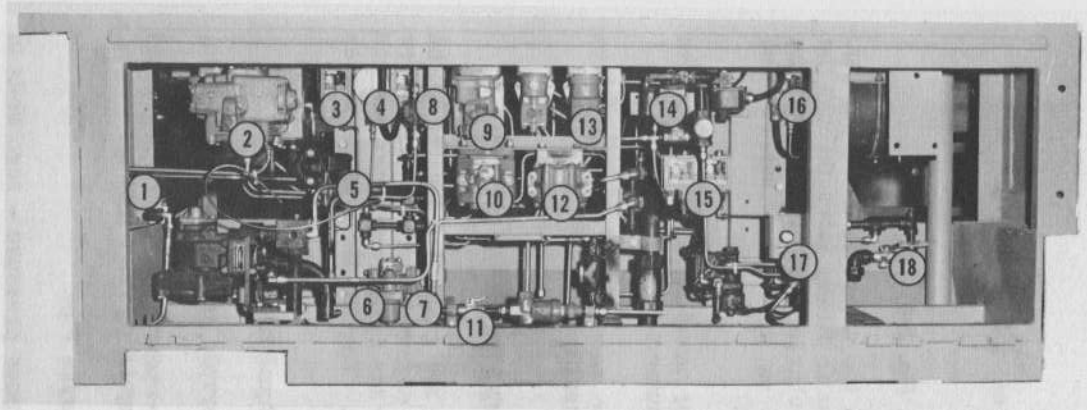
1. Main Reservoir and Equalizing Reservoir

   a. Normal main-reservoir pressure 130 to 140 lb.

   b. Proper equalizing-reservoir pressure – should correspond with regulating-valve setting.

2. Brake Cylinder and Brake Pipe

   a. Proper brake-cylinder pressure – zero while in the running position. Approximately 45 pounds



1 Control-reservoir drain cock
2 26F control valve
3 Emergency-sanding pressure switch
4 Control air gage
5 Brake-pipe cut-out cock and strainer
6 Control-air regulating valve
7 Control-air supply cock
8 Pressure switch (PCS)
9 P-2A brake-application valve
10 A-1 charging cut-off pilot valve
11 Dead-engine cut-out cock
12 F1 selector valve
13 HB-5 relay air valve (fail safe)
14 Wheel-slip cut-out cock
15 MU Sanding Signal
16 Wheel-slip sanding pressure switch
17 Test button (slip suppression)
18 Auxiliary air supply

Fig. 5-3. Air-brake equipment

Fig. 5-3 (E-14699)

when the independent brakes are fully applied on cast-iron brake-shoe equipped trucks.

b. Proper brake-pipe pressure – should correspond with regulating-valve setting and equalizing-reservoir pressure.

3. Application Pipe and Suppression Pipe

a. Application Pipe – During normal operation, main-reservoir pressure is registered. When a penalty occurs, caused by train speed control or safety control (when so equipped), the warning whistle will sound and the gage pressure will start reducing.

b. Suppression Pipe – Registers the amount of suppression in accordance with the brake pipe reduction (when so equipped).

The function of the single-pointer gages are as follows:

Control Air – Reference gage used when adjusting the control-air pressure. Normal control-air pressure is 70 pounds.

Main Reservoir Air – Reference gage used when adjusting air-compressor governor.

CUT-OUT COCKS

The following air brake system and auxiliary air system cut-out cocks are located throughout the locomotive:

1. Main-reservoir Cut-out Cock

Located adjacent to the main-reservoir air filter.

2. Main-reservoir Drain Cocks

One located on the end of each main reservoir, usually a part of the automatic drain valve.

3. Control Air Cut-out Cock

Normally located in the air brake compartment.

4. Control Air Reservoir Drain Cock

Located in the air brake compartment.

5. Brake-cylinder Cut-out Cocks (one for each truck)

Located along the right side of the locomotive at the lower edge of the platform (one at each truck centerplate).

6. Safety-control (Deadman) Cut-out Cock

Located in the air brake compartment. Cuts out the safety control feature when closed. Normally sealed in the OPEN position.

7. Bell, Horn, and Window-wiper Cut-out Cock

Located in the air brake compartment.

8. Angle Cocks at each end of Locomotive

a. Brake Pipe

b. Brake Cylinder Equalizing

c. Actuating

d. Main Reservoir Equalizing

e. Signal (If equipped)

f. Forward Sand (Pneumatic sanding only)

g. Reverse Sand (Pneumatic sanding only)

9. Air Compressor Governor Cut-out Cock

Located near the compressor synchronization panel beside the lube-oil cooler.

10. Overspeed Control Cut-out Cock

Located in the air brake compartment. Normally sealed in the OPEN position.

11. Automatic Wheel Slip Sanding Cut-out Cock

Located in the air brake compartment.

ADJUSTING VALVES

Two manually adjustable valves are used in the air system. Their location, function, and adjustment are as follows:

1. Regulating Valve

Located on the brake stand. Automatically maintains a predetermined normal air pressure in the brake system. A clockwise movement of the adjusting handle increases the pressure setting. (Adjust to conform with railroad regulations.)

2. Control Air Reducing Valve

This valve maintains a predetermined normal air pressure in the air pressure supply for the operation of control devices such as the reverser, braking switch, and pneumatic contactors. Clockwise adjustment of the adjusting screw increases pressure. Normal control air pressure is 70 psi.

PCS SWITCH

The Pneumatic Control switch (PCS) is pressurized by the air brake system for power knockdown.

During a "safety control" penalty or emergency air brake application, this switch opens dropping the PCR relay. Engine speed is normally reduced to IDLE and power is removed.

To reset the PCS switch, if operation is due to a penalty brake application:

1. Move the Throttle Handle to IDLE.

2. Move the Automatic Brake Valve handle to SUPPRESSION.

3. Depress the Safety Control foot pedal (if used). (When the application pipe builds up to normal pressure, PCS will reclose.)

4. After the application pipe has built up to normal pressure, move the Automatic Brake Valve handle to RELEASE.

SAFETY CONTROL

Safety Control (if installed) consists of a foot-operated air valve, whistle, and a sealed cut-out cock. Except when the locomotive is stopped and independent locomotive brakes are applied, the engineman must keep the safety control pedal depressed. This prevents a safety control brake application.

After a penalty brake application has occurred, normal locomotive operation is restored in the following manner:

1. Move the Throttle handle to IDLE.

2. Move the Automatic Brake Valve handle to SUPPRESSION.

3. Depress the Safety Control foot valve.

4. After the application pipe has built up to normal pressure, move the Automatic Brake Valve handle to RELEASE.

MULTIPLE-UNIT OPERATION

When a locomotive unit with 26-L equipment is operated in multiple (lead or trailing) with 24-RL equipped units, or with units equipped with brakes of the No. 6 type, the following hose connections must be made:

HOSE CONNECTIONS

Schedule 26-L	M-U with Schedule 24-RL	M-U with Schedule 6
Brake Pipe	to Brake Pipe	to Brake Pipe
M. R. Equalizing Pipe	to M. R. Equalizing Pipe	to M. R. Equalizing Pipe
Actuating Pipe	to Actuating Pipe	-----
B. C. Equalizing Pipe	to Ind. Appl. & Rel. Pipe	to B. C. Equalizing Pipe
Sanding Pipe	to Sanding Pipe	to Sanding Pipe

26-L and 24-RL equipped locomotive units can be operated together in any combination.

26-L and No. 6 equipped locomotive units can be operated together in any combination.

With the 26-L equipped locomotive leading one or more 24-RL equipped locomotive units, No. 6 equipped units with or without actuating pipe can trail.

A unit having No. 6 type equipment can be operated (only if it has an actuating pipe) between a leading 26-L equipped unit and a trailing 24-RL or 26-L equipped unit.

CHANGING ENDS

To change the controls from the cab of one locomotive unit to the cab of another, first make a Full Service brake pipe reduction; then, depress the handle of the Brake Valve Cut-out cock and move it to OUT position. Place the Automatic Brake Valve handle in the HANDLE-OFF position and the Independent Brake Valve handle in the RELEASE position. Depress the handle of the MU-2A valve and move it to TRAIL-6, TRAIL-24 or TRAIL-26 positions, depending on the type of equipment employed on the LEAD locomotive. This locomotive is now set up as a trailing unit.

Proceed to the cab of the other locomotive; insert the Automatic Brake Valve handle in the HANDLE-OFF position, and move the Independent Brake Valve handle to the FULL APPLICATION position. Depress the handle of the MU-2A valve and move it to LEAD or DEAD position. Depress the handle of the Brake Valve Cut-out cock and move it to the IN position as required by the service in which the locomotive is to be operated.

BREAK-PIPE LEAKAGE TEST

With the brake system fully charged and with the Brake Valve Cut-out cock in the IN position, move the Automatic Brake Valve handle promptly toward the SERVICE position until the equalizing-reservoir pressure has been reduced 15 psi. Then, stop and leave the handle in this position.

As soon as the brake pipe pressure has reduced to the level of the equalizing-reservoir pressure (continuous blow from brake valve exhaust), depress the Brake Valve Cut-out Cock handle and move it to the OUT position. Immediately observe the brake pipe gage and time the pressure drop in accordance with Railroad Instructions.

At the completion of the brake pipe leakage test, move the Brake Valve handle further towards the SERVICE position and reduce the equalizing reservoir pressure slightly below the brake pipe pressure. The brakes may later be released by returning the Brake Valve handle to the RELEASE position.

DEAD-IN-TRAIN

1. Place the Independent Brake Valve handle in the RELEASE position and the Automatic Brake Valve handle in the HANDLE-OFF position.

2. Depress the Brake Valve Cut-out cock handle and move it to the OUT position.

3. Depress the handle of the MU-2A valve and move it to "LEAD or DEAD" position.

4. Drain the main-reservoir pressure down below 30 psi.

5. Open the Dead Engine Fixture Cut-out cock located in the air brake compartment.

AIR-BRAKE EQUIPMENT MAINTENANCE

BRAKE VALVE

The brake valve should be tested for leakage at regular inspection intervals. This test can be done without removing the valve from service. Proceed as follows:

1. Place the Brake Valve handle in the RELEASE position.

2. Test all exhaust openings with soap suds.

3. Move the Brake Valve handle to the FULL SERVICE position.

4. Test all exhaust openings with soap suds.

If any excessive leakage is discovered, the brake valve should be removed from the pipe bracket and replaced by a brake valve in good condition. At regular maintenance intervals, the brake valve should be dismantled, cleaned, and lubricated in accordance with proper maintenance instructions.

CONTROL VALVE

Never remove movable parts from a valve while it is still on the locomotive. Any attempt to take the valve apart while still on the locomotive is certain to result in a large number of valves being damaged by careless handling or by getting dirt inside the valve. If the "Service Portion" is not working properly or needs cleaning and oiling, remove it from the pipe bracket and replace it with a "Service Portion" which is in good condition. All cleaning and oiling should be done at a bench, by a competent man, where the possibility of damaging internal parts of the valve is at a minimum.

Cleanliness is extremely important when handling disassembled air brake devices. All devices or parts must be properly protected to prevent the entrance of dirt or water. Also, proper protection prevents damage to internal parts.

The interval between control valve cleanings is best determined for each application by careful inspection and trial. Where conditions are severe and the control valve is exposed to extreme weather conditions or dirt contamination, the cleaning, oiling, and testing must be done at shorter intervals than where conditions are more favorable.

AIR EQUIPMENT

GASKETS AND DIAPHRAGMS

Gaskets and diaphragms may be dipped in a suitable solvent to assist in the removal of greasy dirt. However, parts must be promptly wiped dry after cleaning and must not be allowed to soak in the cleaning fluid.

Gaskets which have broken or flattened heads, or which reveal cracks or cuts in diaphragms or sealing surfaces, must be replaced. Serviceable gaskets must then be brushed with a soft-bristle brush (such as a shoe brush) to remove any remaining dirt and to polish them.

CHOKES

The size of chokes is extremely important to the proper operation of the air system. Whenever a portion of a choke is disassembled, the choke fittings must be cleaned and inspected to ensure that they are not restricted.

Choke plugs can be readily applied or removed without damage to the choke plug or to the threads in the tapped hole. Use Allen or splined socket wrenches. These chokes must be removed, cleaned, and replaced one at a time to avoid misplacement. While the chokes are removed, the passages must be checked for cleanliness and blown out if necessary. As each choke is cleaned, it must be replaced before the next choke is removed. Metallic tools must not be used for cleaning chokes, as the size of the choke must not be changed.

SPRINGS

All springs must be inspected after cleaning. Any that show rust pits, distortion, or have a permanent set must be replaced with correct new ones.

AIR EQUIPMENT

THREADS

The threads of choke plugs and all other removable plugs, as well as other threaded parts which may later be difficult to remove, should be coated lightly with a compound of one part graphite (current AAR Specification M-913) and two parts of oil (SAE-20).

BROKEN PIPES

When it becomes necessary to move a locomotive with a broken air pipe, a temporary repair can be made. However, one or more operational functions will be lost and the locomotive should be handled accordingly.

Make temporary repair to the broken air pipe to stop air leakage by closing appropriate cocks, inserting pipe plugs, or crimping (for tubing), depending on the most suitable method. The effects on brake operation for the principal pipes are listed below. Any interference with automatic brake operation will affect the train brake operation as well as the brakes of the locomotive unless otherwise noted.

Main Reservoir Pipe – The automatic and independent brakes are inoperative. If the break is located between the main reservoirs, the second main reservoir may be utilized for dead engine operation.

Brake Cylinder Pipe – The locomotive brakes will not apply during brake applications. However, separate cut-out cocks are provided for each truck to permit possible operation of brake cylinders on other truck, depending on the location of the break.

Brake Cylinder Application Pipe (No. 16) – The automatic brake on the locomotives will not apply. The train brakes are not affected and will operate.

Equalizing Reservoir Charging Pipe (No. 15) – The automatic brake is inoperative. Independent brakes will operate.

Equalizing Reservoir Control Pipe (No. 5) – The automatic brake is inoperative. Independent brakes will operate.

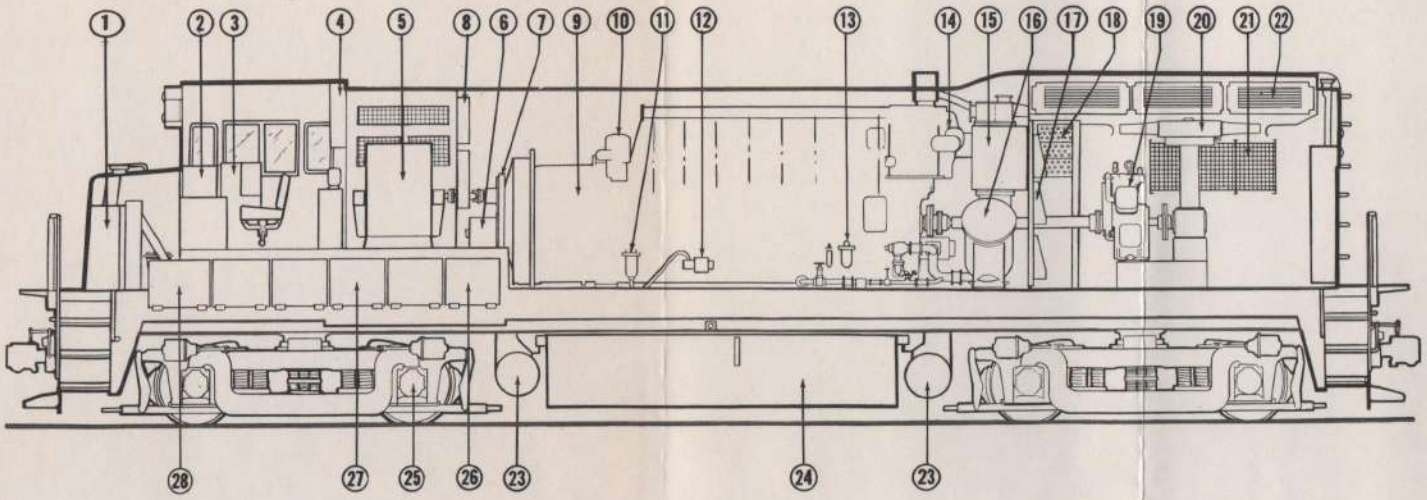
Brake Pipe (No. 1) – The automatic brake is inoperative unless the break is located in the branch pipe, other than the brake-valve branch pipe. In this case, the automatic brake will operate, but the function of the affected device is lost.

Independent Application and Release Pipe (No. 20) - The independent brake is inoperative. The automatic brake will operate.

Actuating Pipe (No. 13) – No independent release of automatic brake application on locomotives by depressing the brake valve handle. Independent and automatic brakes will operate.

AIR EQUIPMENT

Fig. 5-4 (E-14698)



1 Sand box
2 Operating controls
3 Air-brake controls
4 Engine control panel
5 Equipment blower
6 Auxiliary generator (left side)
7 Traction-alternator gear case
8 Power rectifier panels
9 Traction alternator
10 Engine control governor
11 Fuel strainer
12 Fuel booster pump
13 Lube-oil fill
14 Turbocharger
15 Water-storage tank
16 Lube-oil filter
17 Oil-bath air filters
18 Engine primary air cleaners
19 Air compressor
20 Radiator fan
21 Dynamic-brake grids (when equipped)
22 Radiator
23 Air reservoir
24 Fuel tank
25 Axle generator (one per axle)
26 Batteries (right side)
27 Air-brake compartment (right side)
28 Control compartment (left side)

Fig. 5-4. Apparatus location